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JUL 23 2010

IN REPLY REFER TO:
HWY-DS 2.5958

JUL 12 2010

TO: THE HONORABLE KATHERINE P. KEALOHA, DIRECTOR
OFFICE OF ENVIRONMENTAL QUALITY CONTROL

FROM: BRENNON T. MORIOKA, Ph.D., P.E.
DIRECTOR OF TRANSPORTATION

SUBJECT: FINAL ENVIRONMENTAL ASSESSMENT FOR AIEA STREAM EROSION CONTROL IN THE VICINITY OF THE INTERSTATE H-1 FREEWAY
PROJECT NO. H1E-01-09

The Hawaii State Department of Transportation (HDOT) has reviewed the comments received during the 30-day public comment period which began on May 23, 2010. HDOT has determined that this project will not have significant environmental effects and has issued a FONSI. Please publish this notice in the July 23, 2010 OEQC Environmental Notice.

We have enclosed a completed OEQC Publication Form; one copy of the document in pdf format on CD; and one printed copy of the Final EA.

Should you have any questions, please contact our Project Manager, Emilio Barroga at 692-7546, Technical Design Services Office, Design Branch, Highways Division or by email at Emilio.Barroga@hawaii.gov.

Enclosures
OEQC Publication Form
Final EA (CD and printed copy)

Final
Environmental Assessment

Aiea Stream Erosion Control
In the Vicinity of the Interstate H-1 Freeway
Aiea, Hawaii

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

July 7, 2010

Summary Information

Project Name	Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
Proposing Agency	State of Hawaii Department of Transportation Highways Division 869 Punchbowl Street Honolulu, Hawaii 96813
Tax Map Key	9-9-042: 027 and 059
Project Description	The Highways Division of the State of Hawaii Department of Transportation (HDOT) proposes to stabilize approximately 180 linear feet of the western (Ewa) bank of Aiea Stream on the makai side of Interstate Route H-1 at Mile Post 12.8 in order to address erosion problems. HDOT proposes to use a construction method called “soil nailing and shotcrete facing” to stabilize the bank.
Required Permits	U.S. Army Corps Permit Water Quality Certification Coastal Zone Management Consistency

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CHAPTER 1
DESCRIPTION OF THE PROPOSED PROJECT

1.1 Introduction

The Highways Division of the State of Hawaii Department of Transportation (HDOT Highways) prepared this Final Environmental Assessment (Final EA) / Finding of No Significant Impact (FONSI) for its proposal to address erosion problems along approximately 180 linear feet of Aiea Stream immediately makai of the Interstate Route H-1 Freeway (H-1 Freeway) in Aiea, Oahu (see Figure 1-1). Hereinafter, this proposal will be referred to as the "Proposed Project".

The pertinent chapters of this document are summarized below:

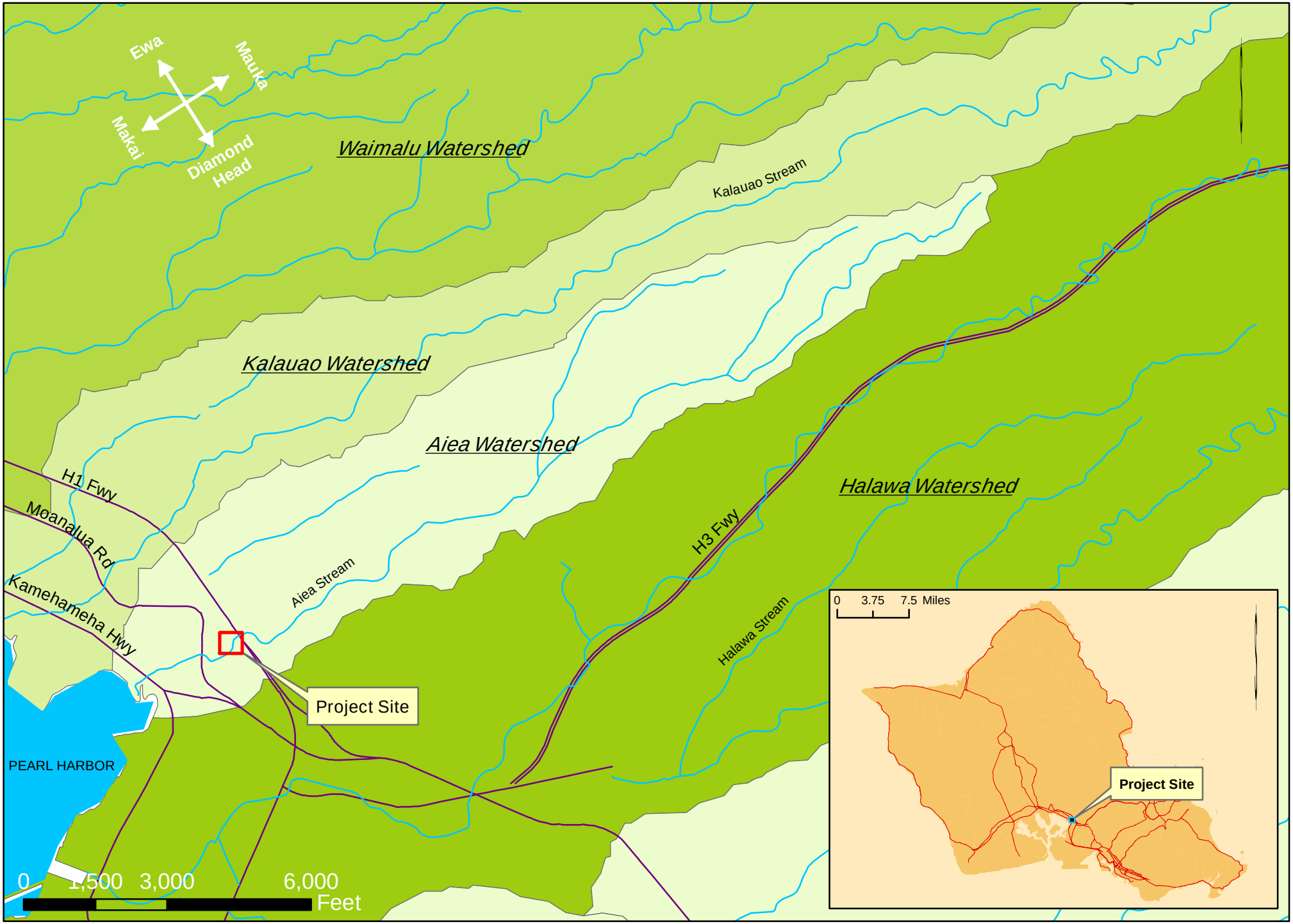
- Chapter 1 identifies the Hawaii State law that requires the preparation of this document; describes why (purpose and need) HDOT Highways is pursuing the Proposed Project; and provides a detailed description of the Proposed Project, including alternatives.
- Chapter 2 describes the existing environmental conditions potentially affected by the Proposed Project; the environmental impacts (construction and long-term) that may result from implementation of the Proposed Project; and the mitigation measures to address those impacts considered to be adverse.
- Chapter 3 summarizes HDOT Highway's public and agency consultation and coordination activities for the Proposed Project.
- Chapter 4 provides an assessment of why the Proposed Project will not cause a significant impact as defined in Section 11-200-12(b) of the Hawaii Administrative Rules.

1.2 Planning Context

The provisions of Chapter 343 of the Hawaii Revised Statutes (HRS) apply to the Proposed Project because State funds will be used for construction. In addition, the Proposed Project would not be exempted from environmental review as defined in HAR Section 11-200-8(a). The actions under the Proposed Project are not listed in HDOT's Comprehensive Exemption List (amended, November 15, 2000).

HDOT Highways rendered a preliminary determination that the Proposed Project is not likely to have a "significant" impact as defined in HRS Section HAR 11-200-12(b). After receipt of comments on the Draft EA, which was announced in the May 23, 2010 edition of the Environmental Notice published by the State of Hawaii Office of Environmental Quality Control, HDOT Highways confirmed its FONSI determination. The issuance of the FONSI will be announced in the Environmental Notice.

This Final EA / FONSI discloses the environmental and social impacts that could result from the Proposed Project's implementation, and commits to the implementation of specific measures to prevent, minimize or mitigate adverse impacts to the environment. Additionally, this Final EA / FONSI contains a record of all comments and consultation activities that have been conducted to date as part of project planning, including comments received due to the release of the project's Draft EA.



Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
Environmental Assessment

Project Location
Figure 1-1

1.3 Purpose and Need

The Proposed Project's objective is to remediate erosion problems occurring along Aiea Stream immediately makai of the H-1 Freeway. The stream is highly degraded, showing extreme erosion along its banks. Under the H-1 Freeway, the stream passes through a double cell box culvert. Each culvert cell is 15 feet wide and 12 feet high. Water flow within the stream is intermittent, and therefore, erosion occurs during storm events when water flow is large and rapid. Shortly after storm events, the stream bed returns to its normal dry condition. The erosional area proposed to be remediated is along the western (Ewa) bank of the stream. The soil loss along the bank is undermining perimeter fence foundations and concrete slabs that are part of Aiea Shopping Center. The concrete slabs are used to support equipment and utility pipes. Erosion is also occurring below an existing 42-inch diameter corrugated metal drainage pipe on the stream's eastern (Diamond Head) bank, approximately 125 feet downstream from or makai of the H-1 Freeway culvert outlets. The drainage pipe carries storm water from portions of the H-1 Freeway and Laka Place, a street running parallel to the H-1 Freeway, with a cul-de-sac on the Diamond Head side of the stream.

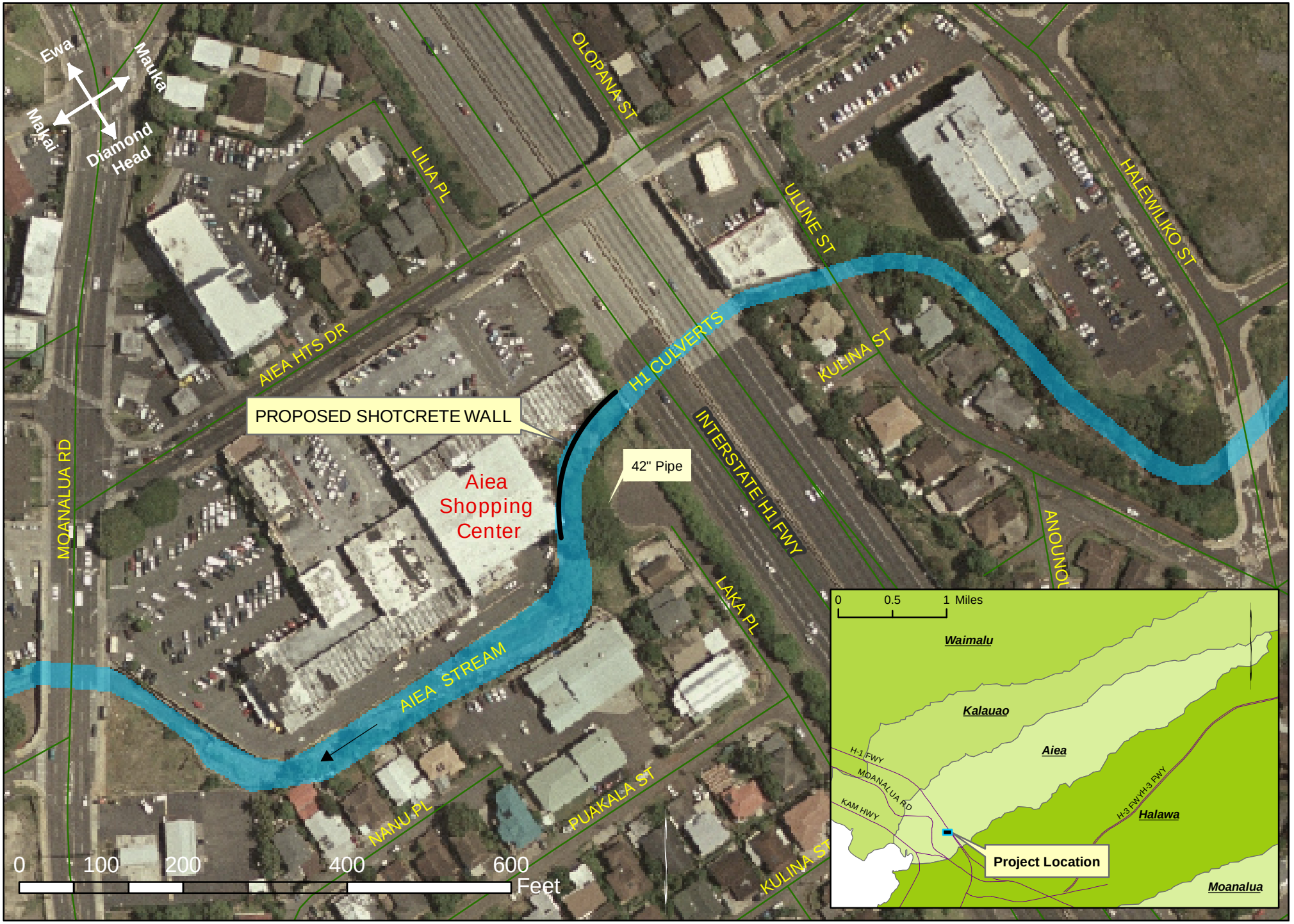
1.4 Description of the Proposed Project

The Proposed Project will stabilize a portion of the Ewa bank of Aiea Stream. The project limits will start from the H-1 Freeway culvert outlets at the upstream (mauka) end and at a point approximately 180 feet on the downstream (makai) end (see Figure 1-2). Most of the project or construction area will be within the privately-owned Aiea Shopping Center where the eroded stream bank requires protection and strengthening to prevent further undercutting. The portion of the project site that is on public property is part of the H-1 Freeway right-of-way.

The proposed method of stabilizing the stream bank is called "soil nailing and shotcrete facing". Shotcrete is a method of pneumatically applying concrete with coarse aggregate mixture on surfaces using air compression applied through a hose and nozzle. As a result of the high velocity spray from the hose nozzle, the shotcrete undergoes placement and compaction at the same instance that the shotcrete is applied to a surface. Therefore, shotcrete can be placed on a variety of surface shapes, including steep and vertical walls. Soil nailing is a technique used to reinforce and stabilize slopes, excavations or retaining walls. Narrow bars or anchors are inserted from the ground surface or fastening wall facing, such as shotcrete (see Figure 1-3).

The construction process of the "soil nailing and shotcrete facing" method at the project site is as follows (see Figure 1-3):

1. Vegetation, trees and loose soils and rocks will be removed along the Ewa bank within the project limits.
2. Ground anchors will be installed on the stream bank and will extend into the Aiea Shopping Center property.
3. The ground anchors will be covered with shotcrete.
4. Drainage will be provided through the shotcrete facing.



Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
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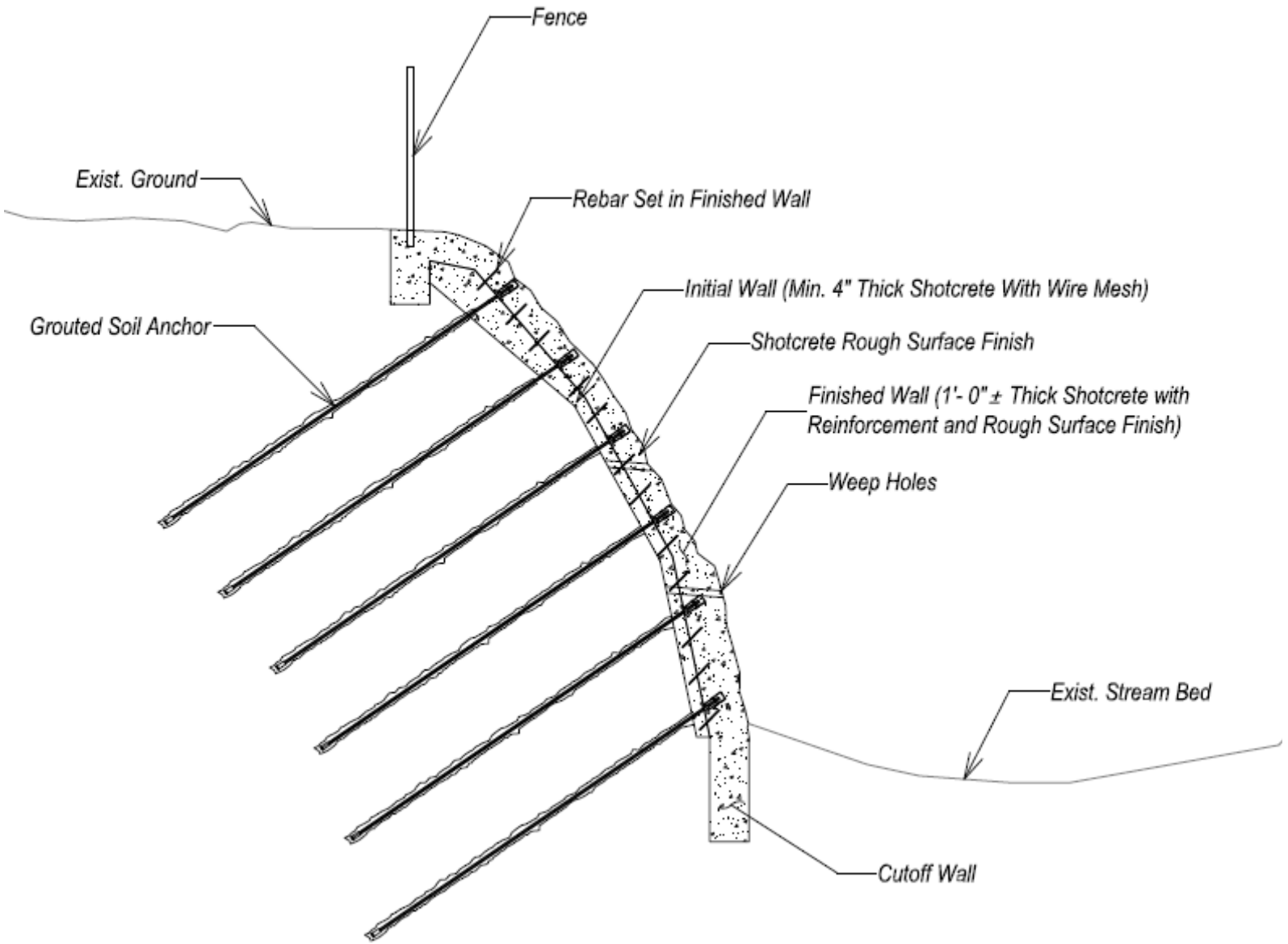
Project Site
Figure 1-2



Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
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Sectional View of Proposed Bank Stabilization
Figure 1-3

The remaining parts of the existing stream bed unaffected by the installation of the shotcrete wall will remain relatively rough, boulder laden and undulating. However, the contractor will likely use sections of the stream bed for construction access, operation of construction vehicles and equipment, but not for storage. The contractor will be required to minimize disturbance of the stream bed and banks to the extent practicable and will be required to restore affected areas of the stream bed and banks to pre-construction conditions, where necessary.

In addition to bank stabilization work, the Proposed Project will realign the discharge of the existing 42-inch diameter drain pipe more downstream. Presently, the discharge is perpendicular to the stream flow.

The conceptual construction cost estimate of the Proposed Project will be between $900,000 and $1.1 million. Final design and the acquisition of required permits are tentatively scheduled for the latter half of calendar year 2010. Construction of the Proposed Project is scheduled to start during the first half of calendar year 2011, and will take approximately 6 months to complete.

1.5 No Build Alternative

Full consideration is given in this EA to the environmental consequences of taking no action to meet purpose and need as described in Section 1.2. For the purposes of analyzing the impacts of the Proposed Project, the No Build alternative provides a baseline condition with which to compare the consequences associated with the Proposed Project. Under the No Build alternative, no effort would be made to stabilize the Ewa bank. To lessen the impedance of stream flow as much as possible, the City has a stream maintenance easement for the purpose of periodically removing vegetation and debris from the stream bed.

1.6 Alternatives Considered But Rejected

In addition to the Proposed Project, the following two alternatives were considered to address the purpose and need described in Section 1.2:

1. U-shaped concrete channel
2. Box culvert

Both of these alternatives were rejected because in comparison to the Proposed Project described in Section 1.3, either alternative would substantially disturb or change the stream bed and banks; would be more costly; and would take longer to construct. Brief descriptions of the rejected alternatives are provided below:

U-Shaped Concrete Channel Alternative. The concrete channel would be approximately 30 feet wide at the base or along the stream bed, with 18-foot high walls. The length of the channel would be approximately 200 feet starting from the H-1 Freeway box culvert, plus a 30-foot long apron on the downstream side of the channel. Energy dissipators, which could have steps or baffles, would be placed on the channel apron to slow the velocity of the storm water as it exits the channel. Other elements of this alternative include chain link fencing on the top of both channel walls; and connecting the 42-inch drainage pipe to the channel wall where storm water from the pipe discharges into the channel. The conceptual construction cost estimate of the U-shaped concrete channel alternative is approximately $2.6 million.

Box Culvert Alternative. A wide 32-foot wide by 12-foot high single cell concrete box culvert would be installed immediately downstream of the H-1 Freeway, as an extension of the existing box culvert. The length of the culvert would be approximately 200 feet, plus a 30-foot long apron at the downstream outlet. Similar to the U-shaped concrete channel alternative, energy dissipators would be placed on the downstream side of the culvert to slow the velocity of the storm water as it exits the culvert. Also, the 42-inch drainage pipe would be connected to the culvert wall where storm water from the pipe discharges into the culvert. The conceptual construction cost estimate of the U-shaped concrete channel alternative is approximately $3.5 million.

CHAPTER 2
AFFECTED ENVIRONMENT, POTENTIAL IMPACTS AND PROPOSED MITIGATION

This chapter describes potential short-term construction and long-term or operational environmental impacts of the Proposed Project. In addition, the potential long-term impacts of the No Build Alternative, or doing nothing, are also described as a point of comparison. Where an impact is considered adverse, mitigation measures are provided.

Based on the elements and potential impacts of the Proposed Project in the context of the environmental and social conditions of the study area, this chapter focuses on the following environmental issues:

Natural Environment

- Geologic and Soil Conditions: long-term impacts to surface and subsurface soils and modification of the existing topography as a result of the Proposed Project
- Water Resources: potential temporary construction-related and long-term impacts to Aiea Stream, including the potential for future erosion, the effects on water quality and whether or not the flood zone associated with the stream may change
- Biological Resources: potential temporary construction-related and long-term impacts to the biological resources within the project site
- Air Quality: potential temporary construction-related impacts to air quality in the immediate vicinity of the project site
- Noise: potential temporary construction-related impacts in the immediate vicinity of the project site
- Visual and Aesthetic Resources: the potential long-term impact to the existing visual and aesthetic environment

Social and Built Environment

- Land Use: identification of the existing land uses that may be protected from erosion by the Proposed Project
- Roadways and Traffic: potential temporary construction-related impacts to the operation of roadways near or adjacent to the project site

Consistency with Governmental Plans and Policies: The Proposed Project's consistency with the following governmental plans and land use controls that apply to the project site:

- Hawaii State Plan
- Coastal Zone Management
- City and County of Honolulu (City) General Plan
- City Primary Urban Center Development Plan

Based on site reconnaissance and project scoping activities (see Chapter 3), the following types of environmental resources are unlikely to be affected by the Proposed Project, and therefore, detailed analyses of project impacts to these resources are not included in this chapter:

Natural Environment

- Long-Term Air Quality Conditions: Upon completion, maintenance is the only activity that involves air pollutant emissions. The City maintains a maintenance easement within the stream, and City staff will continue to use hand-held equipment, such as gas-powered (and air pollutant exhaust producing) weed trimmers, to control vegetation or clear trash and debris within the stream bed, which may cause impediments to storm water flow. However, this activity will be relatively brief and infrequent, and will occur regardless of whether or not the Proposed Project is implemented.
- Long-Term Noise Conditions: Maintenance activities as described above will produce noise, but such activities will be relatively brief and infrequent, and will occur regardless of whether or not the Proposed Project is implemented. In addition, the high traffic noise levels from the H-1 Freeway dominate the ambient noise conditions in around the project site, which may make maintenance-related noise not as noticeable as one would otherwise expect.
- Wetlands: According to the U.S. Fish and Wildlife Service's (FWS) National Wetlands Inventory (NWI) and on-site observations, the project site does not contain wetlands.
- Groundwater: Any groundwater within the project site is not used for potable drinking purposes.
- Wild and Scenic Rivers: Aiea Stream is not federally designated as a wild and scenic river or State scenic river.
- Threatened and Endangered Species: The project site is highly disturbed from its original natural vegetation and habitat, having been surrounded by large-scale agriculture (sugarcane cultivation throughout the latter half of the 19th century and early part of the 20th century) and urban land uses for many decades thereafter. The project site is not considered a wildlife refuge or critical habitat, and is highly unlikely to contain federally or State-designated threatened or endangered species.

Social and Built Environment

- Social Conditions and Neighborhoods: Social, community or public service activities occurring in nearby areas will be unaffected by the Proposed Project, which will be confined to the existing Aiea Stream.
- Economic Conditions: Economic activities, such as commerce at the adjacent Aiea Shopping Center, will be unaffected by the Proposed Project, which as noted above will be confined to the existing Aiea Stream.
- Historic Properties: The project site (Aiea Stream) is highly unlikely to contain sites or resources eligible for the National Register of Historic Places or the Hawaii Register due to the disturbed condition of the project site, which have included large scale agriculture, urban development, and past storm events. In a letter dated November 4, 2009, the State Historic Preservation Division stated agreement with this assessment, noting "no historic properties affected" within the project site.
- Parks and Recreational Resources: No park or recreational resource will be affected because the Proposed Project will be confined to the existing Aiea Stream.
- Long-Term Traffic Conditions: Upon completion, traffic conditions will not be affected because the Proposed Project will be confined to the existing Aiea Stream.
- Farmland: The project site and the immediate surrounding areas do not contain working farms.
- Utilities: The only active utility within the project site is HDOT-owned 42-inch drain pipe, which will be realigned under the Proposed Project.

Governmental Plans and Policies

- Hawaii State Land Use Controls: The project site is in the State Urban area, the least restrictive of the four State classifications.
- City and County of Honolulu Zoning: Within the project site, Aiea Stream demarcates two zones: B-2 (Business District) on the Ewa side and R-5 (Residential District) on the Diamond Head side. Regardless of the zoning, the Proposed Project will be considered a "public use" and is a permitted use under both districts.
- Special Management Area: The project site is not within the Special Management Area.

2.1 Natural Environment

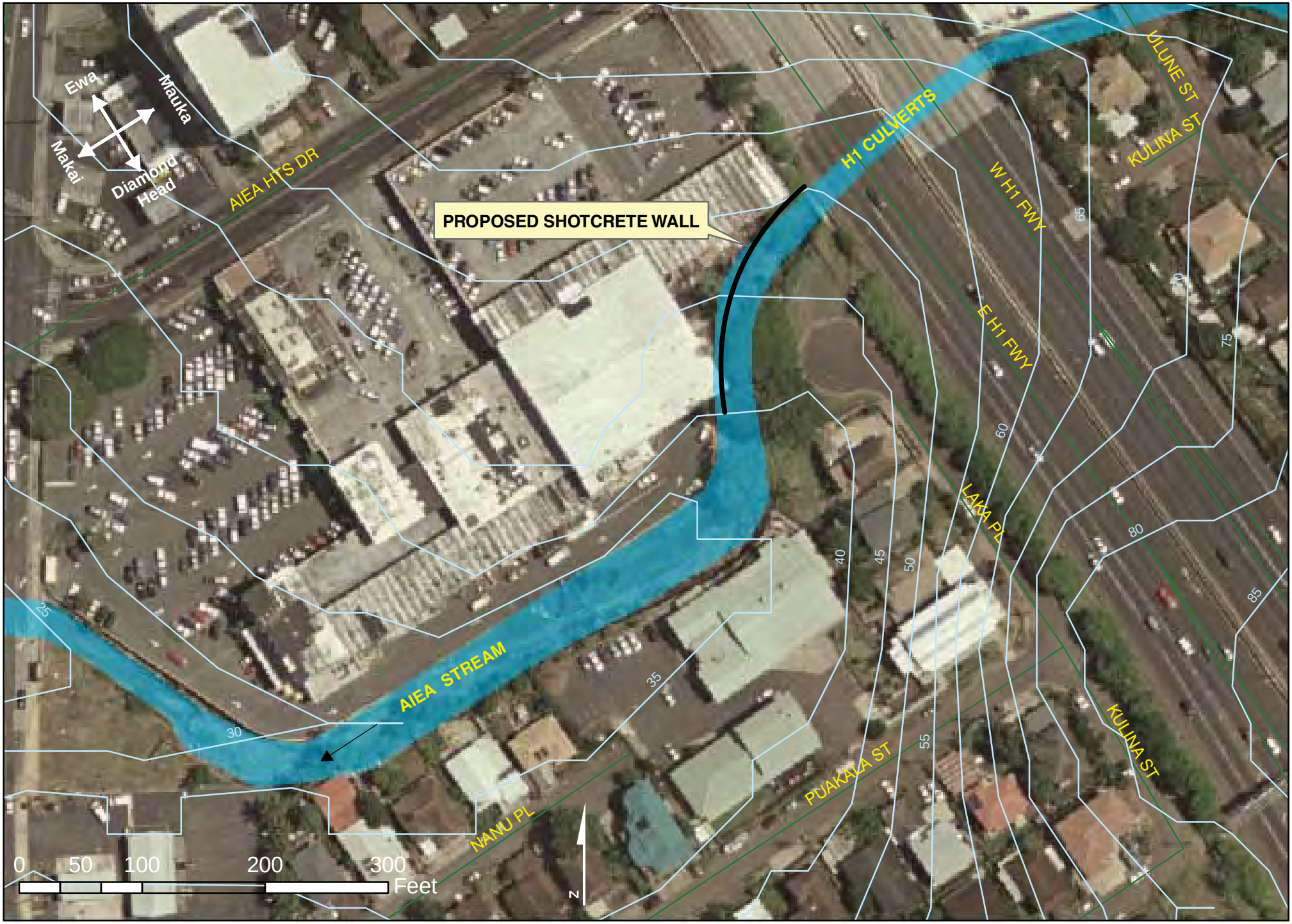
2.1.1 Geographic Setting

2.1.1.1 Existing Conditions

As shown in Figure 2-1, the area surrounding the Aiea Stream within the project site slopes moderately from northeast to southwest, generally following the alignment of the stream. At the H-1 Freeway, the top of the stream bank is approximately 60 feet above mean sea level (msl). The elevations at the downstream portion of the project site are relatively level because the alignment of the stream is somewhat diagonal with the general grade surrounding the stream (see Figure 2-1). The elevations along the Diamond Head bank are a relatively constant 57-59 feet within the project site. The elevation at the downstream end along the Diamond Head bank is actually a half-foot higher than the elevation at the upstream end. Along the Ewa bank, the elevation drops only two feet at the downstream end in relation to the upstream end. The stream bed invert drops in elevation by approximately seven feet within the project site, causing the depth of the channel from stream bed to the top of the banks to increase from approximately 11 feet at the upstream end near the H-1 Freeway culverts to approximately 20 feet at the downstream end.

The slopes mauka and makai of the Proposed Project are substantially steeper. For instance, within 400 feet downstream of the project site, the elevations of the top of banks drop by approximately 15 feet because the stream shifts to a mauka-makai alignment beyond the project site. On the Diamond Head bank, the elevation drops by almost ten feet just 40 feet downstream from the makai end of the project site. The elevation drop along the stream bed is not nearly as steep, which exposes the land uses makai of the project site to flooding during very low frequency storm events (see Section 2.1.2 for further information).

Figure 2-2 shows the underlying soils in the general vicinity of the project site. According to the U.S. Natural Resources (previously "Soil") Conservation Service's soil survey, the area at and near the project site contains two types of soils: Hanalei silty clay of 2 to 6 percent slope (HnB) and Waipahu silty clay of 0 to 2 percent (WzA) and 6 to 12 percent slope (WzC). "Hanalei" and "Waipahu" soils are alluvium (soil and sediments deposited by a river or other running water) formed from basic igneous rock. The permeability of HnB and WzA/WzC is moderate and moderately slow, respectively. Storm water runoff from HnB, WzA and WzC is slow, slow to very slow and medium, respectively. Erosion hazard from HnB, WzA and WzC is slight, none to slight, and moderate, respectively. A field survey of the stream noted that the upper section of slope along the Ewa bank next to the Aiea Shopping Center, or where the shotcrete wall would be located, may be fill material due to the lack of layering and the presence of angular rocks.



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Elevations in Project Study Area
Figure 2-1

Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
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Soil Types in Project Study Area
Figure 2-2

2.1.1.2 Potential Impacts

Construction

During construction, the Proposed Project along the Ewa bank will require removing loose rocks and soil, vegetation and tree roots. Other activities will include trenching along the toe of the slope for a cutoff wall (see Section 1.4). All excess materials excavated from the project site will be transported away from the site and will be disposed of in a manner compliant with federal, State and City and County of Honolulu regulations. The soil conditions described above are not expected to cause any unusual problems to the design and construction of the Proposed Project, but further investigation, which will include soil boring samples taken from the top of the bank, will be needed to determine the design lengths of the soil nails. The Proposed Project is not expected to affect the structural integrity of the existing Aiea Shopping Center building adjacent to the Proposed Project based on available information about the design of the building.

Long-Term

Once completed, the Proposed Project will maintain the existing topography of the project site, including the shape and alignment of Aiea Stream, although the appearance or façade of the Ewa bank will change to a shotcrete finished wall (see Section 2.1.5). The Proposed Project will generally maintain the shape of the stream bed and its elevations.

The No Build alternative would also maintain the topographic conditions of the project site. However, further erosion may alter the shape and alignment of the stream, which could eventually affect the structural integrity of Aiea Shopping Center. In this case, the shopping center owner may have to take remedial steps to preserve the integrity of its building.

2.1.1.3 Mitigation Measures

The Proposed Project's construction contract documents will require that the contractor practice good housekeeping, such as ensuring that:

- All waste materials be collected and stored in securely lidded metal dumpsters and not buried on site;
- Materials stored on-site be stored in a neat, orderly manner in appropriate containers (i.e., per manufacturer's recommendations);
- All on-site vehicles be monitored for leaks and receive regular preventive maintenance to reduce the chance of leakage; and
- A spill prevention and clean-up plan is prepared and implemented.

All sanitary waste generated during the construction phase will be placed in portable units, as required, for offsite disposal.

If unexpected soil contamination were identified during construction, the contractor will be required to report its findings immediately to HDOT Highways. The handling, treatment and disposal of hazardous materials will be conducted in accordance with applicable State and federal laws.

2.1.2 Water Resources

2.1.2.1 Existing Conditions

The Aiea Stream watershed is located on the leeward slopes of the Koolau Mountain range, between the Halawa Stream and Kalauao Stream watersheds (see Figure 1-1). The Aiea Stream watershed is approximately three and one-half miles long and only 0.65 miles wide at its widest point, with a total area of approximately 834 acres. The upper reaches of the watershed is in a forest preserve called the Keaiwa Heiau State Recreation Area. Approximately two-thirds of the watershed is mixed forest, with the remainder used for urban land uses of mostly residences. Storm water conveyed through Aiea Stream empties into Aiea Bay of Pearl Harbor, approximately a quarter-mile downstream from the project site.

According to the State of Hawaii Department of Health (SDOH), Aiea Stream is listed as a 303(d) water body in accordance with the federal Clean Water Act (CWA). A Section 303(d) listed water body means that it is impaired by at least one pollutant, which affects recreation or the protection and propagation of fish, shellfish and wildlife. According to SDOH, Aiea Stream is impaired by trash and turbidity, and SDOH is in the process of developing or calculating Total Maximum Daily Loads (TMDL) for these pollutants attributable to the stream as required by the CWA. Following development of the TMDL, SDOH would be able to assign Waste Load Allocations (WLA) of the pollutants to certain landowners within the watershed.

Within the project site, Aiea Stream is dry throughout most of the year, with occasional small isolated pools of water. The stream within the project site conveys water only during storm events. The stream bed is rough and undulating, and covered with gravel, cobbles, boulders, weedy vegetation and some trash. As noted in Section 1.3, the Ewa bank is eroded showing bare soil and rocks and exposed tree roots. Despite its intermittent status, Aiea Stream's ordinary high water mark (OHWM) within the project site ranges from approximately one to two feet above the lowest point of any stream cross section within the project site. The OHWM is slightly lower within the H-1 Freeway culverts because the velocity of stream flow within the culverts is relatively higher than velocities along the stream bed.

A hydraulic analysis for the Proposed Project was conducted using the computer model, HEC-RAS version 4.0 (see Appendix B). For purposes of the analysis, the study area extended beyond the project site to an upstream location approximately 150 feet mauka of Ulune Street and a downstream location approximately 400 feet makai of the project site or 300 feet mauka of Moanalua Road (see Figure 2-3). The total length of the study area is approximately 1,100 feet, and includes two culvert crossings, one of which is beneath the H-1 Freeway and the other is beneath Ulune Street. The flood water heights during a 100-year storm event were modeled at 37 cross sections throughout the hydraulic analysis study area based on the existing condition of Aiea Stream. The results are presented in Table 2-1.

Due to the steepness of the stream channel and the H-1 culverts (see Section 2.1.1), the existing flow velocity within the project site is relatively high. In the vicinity of the Aiea Shopping Center where severe erosion is evident, the flow velocity during a 100-year storm event would be nearly 11 feet per second. High flow velocities within the culverts have likely caused scouring below the culvert outfalls. The results of the hydraulic analysis shows that despite the high velocities, Aiea Stream within the Proposed Project site would be able to contain the flood flow during a 100-year storm, as shown in Table 2-1. The project site is

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Hydraulic Analysis Study Area
Figure 2-3

located between stations 306+62 and 304+64 (see Table 2-1). Within this section, the storm water flows would not overtop either bank, with predicted elevations ranging from about 1 ½ feet to almost 10 feet below the banks. However, downstream from the project site, the elevation of the Diamond Head bank drops substantially in comparison to the gradient of the stream bed, which drops relatively moderately (see Section 2.1.1). During a 100-year storm, the Diamond Head bank downstream of station 303+59 would not be able to contain water flows and flooding may occur on adjacent properties. At station 300+42, which is the second to the most makai cross section of the hydraulic analysis study area, the height of the flood waters under existing condition would be over seven feet higher than the top of the Diamond Head bank (see Table 2-1).

Table 2-1
Existing Flood Conditions, 100-Year Storm Flow

Cross Section Station	Elevation - Top of Banks (feet)		Flood Elevation (feet)	Feet Under (-) or Over Stream Bank	
	Diamond Head	Ewa		Diamond Head	Ewa
311+19	75.75	75.64	73.03	-2.72	-2.61
310+87	75.59	76	72.61	-2.98	-3.39
310+57	74.77	74.51	72.04	-2.73	-2.47
310+25	76.57	78	72.06	-4.51	-5.94
309+97	76.05	76.01	72.07	-3.98	-3.94
Ulune St. Culvert	--	--	--	--	--
309+49	69.53	71.8	69.78	0.25	-2.02
309+32	67	71.56	68.28	1.28	-3.28
309+08	68	71.56	66.01	-1.99	-5.55
308+89	66.42	71.56	64.17	-2.25	-7.39
308+69	63.64	71.56	61.79	-1.85	-9.77
308+54	60.9	71.56	57.85	-3.05	-13.71
308+42	60.58	60.48	50.34	-10.24	-10.14
H-1 Fwy. Culvert	-	--	--	--	--
306+62	57.64	60	56.78	-0.86	-3.22
306+46	57.97	58	56.31	-1.66	-1.69
306+29	57.93	62	56.21	-1.72	-5.79
306+09	59.9	62.18	54.93	-4.97	-7.25
305+79	58.8	59.99	54.36	-4.44	-5.63
305+51	57.99	61.99	52.01	-5.98	-9.98
305+23	58	59.98	50.42	-7.58	-9.56
304+92	58.17	58.09	49.41	-8.76	-8.68
304+84	58	58.05	49.47	-8.53	-8.58
304+64	58.02	57.8	48.14	-9.88	-9.66
304+44	48.21	56.1	47.47	-0.74	-8.63
304+21	46.67	54	46.58	-0.09	-7.42
303+93	46.36	55	46.15	-0.21	-8.85
303+59	44.21	53.95	45.40	1.19	-8.55
303+19	42.83	50.15	44.47	1.64	-5.68

Table 2-1
Existing Flood Conditions, 100-Year Storm Flow
(continued)

302+92	41.74	48.2	43.20	1.46	-5
302+50	40.81	45.5	41.87	1.06	-3.63
302+10	40.07	43.27	40.40	0.33	-2.87
301+78	39.79	43.21	40.05	0.26	-3.16
301+49	36.86	44.19	39.89	3.03	-4.3
301+22	37.33	44.56	39.61	2.28	-4.95
300+95	35.42	44.4	39.36	3.94	-5.04
300+68	34.44	43.24	39.29	4.85	-3.95
300+42	32	42.75	39.27	7.27	-3.48
300+16	33.39	42.75	38.89	5.5	-3.86

Source: PB Americas, Inc.

The results of the hydraulic analysis are generally consistent with existing flood insurance rate maps (FIRM) of the study area. Similar to the results of the hydraulic analysis, the FIRM maps show the width of the floodway (AE zone) bulging outside the stream banks immediately downstream from the project site.

2.1.2.2 Potential Impacts

Construction

During construction, additional erosion and sedimentation (from normal conditions) within Aiea Stream could occur during a storm event when water flow is present, which may adversely affect the quality of the water that is discharged into Aiea Bay in Pearl Harbor. The Proposed Project will be under the one acre which is the threshold that would trigger the need for a National Pollutant Discharge Elimination System (NPDES) permit associated with construction activities storm water runoff. Best Management Practices (BMP) measures will be implemented during construction as required by the construction contract documents and in compliance with HDOT's Oahu Storm Water Management Program (SWMP).

The lower portion of the shotcrete wall and the cutoff wall will be constructed below the OHWM, which means that the Proposed Project will require a Department of Army permit, pursuant to Section 404 of the Clean Water Act (CWA) from the U.S. Army Corps of Engineers. In addition, a water quality certification (WQC) pursuant to CWA Section 401 will be obtained from the SDOH. Similar to the requirements of the NPDES permit and the Oahu SWMP's Construction Site Runoff Control Program, the WQC requires preparation of erosion control plans and BMPs.

Long-Term

The Proposed Project will not affect SDOH's effort to develop or calculate the TMDL for Aiea Stream, which will remain a 303(d) listed water body with or without the Proposed Project at least within the immediate future. In other words, the TMDL and WLA results will be the same under both the Proposed Project and the No Build alternative. Under the Proposed Project, a shotcrete wall will replace approximately 180 feet of the existing Ewa bank made up of mostly exposed or vegetated soil and rock. The new shotcrete wall will eliminate the erosion of the

section of the bank by the Aiea Shopping Center building, reducing sedimentation during various depths of stream flow occurring during storm events. However, although the Proposed Project will improve the overall water quality of the stream to a slight extent, in the context of Aiea Stream's 834 acre watershed, the reduction in the amount of the watershed's erosion and sedimentation is not expected to be noticeable.

In addition to the existing condition, the hydraulic analysis was applied to Aiea Stream under the Proposed Project by simulating in the hydraulic model a shotcrete wall along the Ewa bank. The shotcrete wall will result in a different friction factor on flood water flows as compared to the existing irregularly-shaped Ewa bank. However, the proposed wall will be designed and constructed with a roughened, textured surface. Therefore, the model predicts that that the flow velocity next to the new shotcrete wall will be approximately five feet per second faster than what the hydraulic model calculates under existing conditions. Near the Diamond Head bank, the model predicts the same flow velocities under both scenarios. Therefore, the flood water conditions along the Diamond Head bank will remain about the same regardless of the alternative selected.

The change in storm water velocity near the Ewa bank will have no substantial effect on flood heights (see Table 2-2). At 25 of the 37 cross sections, the predicted elevations under the Proposed Project will be about the same (within 0.02 feet) as those under existing conditions. At the remaining 12 stations, all of which are within the project site, the predicted flood water surface elevations are slightly lower under the Proposed Project in comparison to existing conditions.

Table 2-2
Flood Conditions under Proposed Project, 100-Year Storm Flow

Cross Section Station	Existing Condition (feet)	Proposed Project (feet)	Predicted Change
311+19	73.03	73.04	0.01
310+87	72.61	72.62	0.01
310+57	72.04	72.06	0.02
310+25	72.06	72.04	-0.02
309+97	72.07	72.07	0
Ulune St. Culvert	--	--	--
309+49	69.78	69.78	0
309+32	68.28	68.28	0
309+08	66.01	66.01	0
308+89	64.17	64.17	0
308+69	61.79	61.79	0
308+54	57.85	57.85	0
308+42	50.34	50.34	0
H-1 Fwy. Culvert	--	--	--
306+62	56.78	56.25	-0.53
306+46	56.31	55.87	-0.44
306+29	56.21	55.74	-0.47

Table 2-2
Flood Conditions under Proposed Project, 100-Year Storm Flow
(continued)

306+09	54.93	54.38	-0.55
305+79	54.36	53.81	-0.55
305+51	52.01	51.80	-0.21
305+23	50.42	50.27	-0.15
304+92	49.41	49.29	-0.12
304+84	49.47	49.11	-0.36
304+64	48.14	47.84	-0.30
304+44	47.47	47.42	-0.05
304+21	46.58	46.39	-0.19
303+93	46.15	46.15	0
303+59	45.40	45.40	0
303+19	44.47	44.47	0
302+92	43.20	43.20	0
302+50	41.87	41.87	0
302+10	40.40	40.40	0
301+78	40.05	40.05	0
301+49	39.89	39.89	0
301+22	39.61	39.61	0
300+95	39.36	39.36	0
300+68	39.29	39.29	0
300+42	39.27	39.27	0
300+16	38.89	38.89	0

Source: PB Americas, Inc.

In summary, the 100-year flood conditions described under existing conditions will remain about the same under both the No Build alternative and the Proposed Project.

2.1.2.3 Mitigation Measures

In compliance with NPDES and construction contract requirements, the construction contractor will be required to provide effective erosion control measures for his construction activities. The contractor will be required to prepare an erosion control or construction BMP plan, which will be included in the WQC application to the SDOH. Generally accepted BMPs applicable to the Proposed Project include:

- Silt curtains and fences;
- Sand bags;
- Fiber rolls and wattles;
- Minimizing areas of disturbance;
- Covering stockpiles; and
- Immediate planting of vegetation and/or mulching on highly erodible or critical areas.

In addition, to the BMPs, the contractor will be required to conduct water quality monitoring in accordance with SDOH requirements.

The results of the hydraulic modeling, which shows no change to the regulatory floodway under the Proposed Project, shall be independently reviewed by a licensed engineer.

2.1.3 Biological Resources

2.1.3.1 Existing Conditions

As noted in Section 2.1.2, Aiea Stream is normally dry with small interspersed pools of water. The mauka to the middle section of the project site support several large to moderately large trees along the top of the banks, forming small canopies. A few of the trees nearest to the stream have exposed tree roots along the banks. The trees are less dense on the makai end of the project site in the vicinity of the Aiea Hongwanji Mission (see Section 2.2.1). The banks and bed of the stream also contains overgrown weedy vegetation.

Due to the normally dry condition of Aiea Stream within the project site, any aquatic life would include the possible presence of insects and certain invertebrate species, such as snails, in the small pools of water. Prior to agricultural, industrial, commercial and residential development of Aiea, including the area surrounding the project site, which occurred throughout the 19th and 20th centuries, the stream probably supported fish species. In an environmental impact statement (EIS) prepared in 1977 by the then City and County of Honolulu Department of Public Works, it was reported that "tilapia (*Tilapia mossambica*) were encountered in fairly large concentrations" at a location 500 to 600 feet upstream from Kamehameha Highway, which is downstream from the project site. The EIS also reported that the section of Aiea Stream subject to the Proposed Project (the project site) "contained no fish or other macro-organisms", other than guppies (family *Poeciliidae*), which were more numerous on the lower part of Aiea Stream. The lack of aquatic species, according to the EIS, was due to discharges from a sugar cane refinery, which was located mauka of the H-1 Freeway but has been closed for several years. The water discharges from the refinery caused the temperature in the stream water to rise to about 106°F at the discharge point. The temperature dropped to 103°F at Moanalua Road, which crosses Aiea Stream a short distance downstream from the project site. The water temperature was too high for the tilapia and native stream species, but according to the EIS, guppies can survive in water temperatures of up to 104°F.

2.1.3.2 Potential Impacts

As noted in Section 1.4, one of the first construction activities of the Proposed Project is the removal of vegetation and trees along the Ewa bank so that shotcrete and soil nailing can then be applied. The loss of several trees, which are on the private property containing Aiea Shopping Center, will not be considered detrimental to the botanical ecosystem of the site or region, and will not be replaced by the Proposed Project.

The Proposed Project will not affect the intermittent water flow condition of the stream. Therefore, aquatic life will remain limited to insects and certain invertebrate species living in small pools of water, which often remain after storm events.

2.1.4 Air Quality and Noise

2.1.4.1 Existing Conditions

Air quality throughout Oahu, including the project site, is generally good due to prevalent northeast trade winds and on-shore breezes that help disperse most urban air pollutants. Data collected by HDOH at ten monitoring stations located throughout the island indicate that air quality on Oahu meets National and State Ambient Air Quality Standards.

The general ambient noise conditions in the general vicinity of the project site are mostly affected by traffic movements along the H-1 Freeway. Vehicles traveling in excess of 55 miles per hour (the posted speed limit) can cause ambient noise levels near the roadway to be in excess of 70dBA. The land uses near the project site do not support industrial businesses or other activities that produce high noise levels (see Section 2.2.1).

2.1.4.2 Potential Impacts

Most air quality impacts during construction generally consist of fugitive dust emissions. Fugitive dust, which refers to airborne particulate matter (PM) of larger particle sizes, will occur during construction, especially activities and situations that include construction vehicles operating around the construction site, excavation activities, material blown from uncovered haul trucks, stockpiles, and exposed areas. The rate of dust emissions from excavation activities varies greatly depending upon the type of soil, the amount and type of earthmoving activity, the moisture content of exposed soil, and wind speed. Most fugitive dust, however, is made up of relatively large particles, which tend to settle within 20 to 30 feet of their source.

Construction activities will involve the use of heavy machinery and vehicles that produce high noise levels. However, construction will be limited to normal daylight hours when loud noises are more tolerable.

2.1.4.3 Mitigation Measures

To prevent fugitive dust from excavation activities and demolition from affecting areas beyond the construction site, HDOT Highway will require the construction contractor to use methods to suppress dust emissions, such as watering during dry conditions, and if necessary, erecting windscreens surrounding the construction site. To prevent haul trucks from tracking dirt onto paved streets, stabilized construction entrances will be installed.

The contractor will be required to comply with the State's Community Noise Control regulations that apply to construction activities.

2.1.5 Visual and Aesthetic Resources

2.1.5.1 Existing Conditions

Within the project site, Aiea Stream is not featured prominently from the perspective of the surrounding private properties and is largely hidden from views available to the general public. For example, the layout of Aiea Shopping Center is such that clientele are not offered views of the stream. The area of the shopping center nearest to the stream is used for truck deliveries. This strongly suggests that the private land owners do not consider Aiea Stream to be a

valuable or noteworthy visual resource, but nevertheless the stream may provide them with an open space resource. Up close, the Ewa bank shows evidence of erosion from previous storm events. At these erosion locations, bare dirt, rock and tree roots are exposed and in some areas vegetative cover is minimal or non-existent.

2.1.5.2 Potential Impacts

Under the No Build alternative, the appearance of Aiea Stream would remain the same. Under the Proposed Project, Aiea Stream would not be more conspicuous than it is today. The stream would remain largely hidden from the surrounding properties and from public vantage points. The shotcrete wall would be inconspicuous from most viewpoints outside of Aiea Stream. However, from viewpoints where the Ewa bank is visible, the appearance of the new bank would be different. Figure 2-4 shows a photo of an eroded section of the Ewa stream bank in the area of the Proposed Project. Although many architectural options are available for the shotcrete wall, the finished wall (the visible part of the shotcrete wall) would have a textured surface facing, simulating a natural façade. In addition, the new stream bank would maintain the natural alignment of the stream. A visual simulation of how the shotcrete wall may appear from the same vantage point of the existing photo is also provided on Figure 2-4.

2.2 Social and Built Environment

2.2.1 Land Use

2.2.1.1 Existing Conditions

The land uses surrounding the project site include the Aiea Shopping Center, the Aiea Hongwanji Mission, and approximately half-a-dozen single-family dwellings (see Figure 2-5). Aiea Shopping Center is a small neighborhood-type commercial mall containing approximately 20 businesses, which includes a super market, a bowling alley, restaurants, salons and dental and insurance offices. Aiea Hongwanji Mission is a Jodo Shinshu Buddhist Temple affiliated with the Honpa Hongwanji Mission of Hawaii. The mission was established in 1902. In addition to religious services, the activities at the mission include Buddhism, martial arts and other educational classes, a pre-school and day care services for seniors.

2.2.1.2 Potential Impacts

The Aiea Shopping Center and the Aiea Hongwanji Mission are the only land uses shown on Figure 2-5 located immediately adjacent to or in the vicinity of the project site.

As described in Section 1.3, erosion along the Ewa bank is undermining perimeter fence foundations and concrete slabs of the shopping center. Under the No Build alternative, further erosion could affect the structural integrity of the shopping center, which might require the shopping center owner to take action to protect its building (see Section 2.1.1). Where constructed, the Proposed Project will stabilize the Ewa bank from further erosion and prevent the undermining of the shopping center.

The Aiea Hongwanji Mission is already protected by a retaining wall along the stream's Diamond Head bank. One of the mission's buildings is just a few feet from the top of the

Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
Environmental Assessment

Existing Aiea Stream Ewa Bank and How it May Appear Under Proposed Action
Figure 2-4

Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
Environmental Assessment

Land Uses in the Vicinity of the Project Site
Figure 2-5

retaining wall. Under the Proposed Project and the No Build alternative, the retaining wall will remain.

The Proposed Project will not affect land use development decisions by adjacent landowners because Aiea Stream will remain relatively inconspicuous.

2.2.2 Roadways and Traffic

2.2.2.1 Existing Conditions

Figure 1-2 shows the existing street network in the general vicinity of the project site. The major roadways surrounding the project site are the H-1 Freeway, Moanalua Road and Aiea Heights Drive. None of these roadways provide vehicular access to the project site.

2.2.2.2 Potential Impacts

During construction, construction vehicles will be directed to access the project site from Laka Place, a local street and cul-de-sac that runs parallel to the H-1 Freeway (see Figure 2-7). A temporary construction driveway will be established between the end of Laka Place and the stream. The small field between the cul-de-sac and the stream, which is owned by the State, will likely be used by the construction contractor for field offices and equipment and vehicle storage. Laka Place is connected to Puakala Street, another local neighborhood road. Puakala Street is connected to Moanalua Road, a major arterial roadway.

During construction, an average of about a dozen trips per day may be generated from the cul-de-sac of Laka Place. Trips will include two to three construction vehicles, such as concrete and/or trucks, with the rest being generated by workers entering and leaving the construction site.

2.3 Consistency with Government Plans, Policies, and Controls

2.3.1 Hawaii State Plan

The *Hawaii State Plan* (June 1991), as codified in HRS Chapter 226, serves as a guide for the future long-range development of the State. It consists of comprehensive goals, objectives and policies for determining priorities and allocating resources. The State Plan promotes the growth and diversification of the State's economy, the protection of the physical environment, the provision of public facilities, and the promotion of and assistance to socio-cultural advancement.

The Proposed Project will support one of the State Plan's land, air, and water quality objectives as set forth in HRS Section §226-13: "maintenance and pursuit of improved quality in Hawaii's land, air, and water resources." (226-13(a)(1)) The Proposed Project will also support three of the policies under HRS §226-13:

- Promote the proper management of Hawaii's land and water resources (226-13(b)(2));
- Promote effective measures to achieve desired quality in Hawaii's surface, ground, and coastal waters (226-13(b)(3)); and

- Reduce the threat to life and property from erosion, flooding, tsunamis, hurricanes, earthquakes, volcanic eruptions, and other natural or man-induced hazards and disasters (226-13(b)(5)).

The Proposed Project will address the need to improve a State water resource, Aiea Stream, by eliminating a source of erosion that may adversely affect the structural integrity of a neighborhood shopping center. In doing so, the Proposed Project will not increase the risk of flooding associated with storm water flows conveyed by Aiea Stream (see Section 2.1.2). Therefore, the Proposed Project will not threaten life and property of those living and working near the project site.

2.3.2 Coastal Zone Management Consistency

The project site is within the State's Coastal Zone Management (CZM) area. The objectives and policies of the Hawaii CZM Program are to protect and manage Hawaii's coastal resources. Activities in the CZM area that require a federal permit or license must be consistent with the CZM objectives and policies. The need for a CWA Section 404 permit (see Section 2.1.2) will trigger the Hawaii CZM program consistency requirement. The Proposed Project may qualify for the "blanket" Hawaii CZM program consistency determination if it is processed under a CWA Section 404 nationwide permit.

2.3.3 City and County of Honolulu General Plan

The *General Plan of the City and County of Honolulu* (1992) is a statement of long-range social, economic, environmental and design objectives for the island of Oahu. It also includes policies to meet these objectives.

The Proposed Project will address the General Plan objective "to protect and preserve the natural environment" (III. Natural Environment, Objective A) by restoring an environmentally damaged area (Policy 2) and designing surface drainage and flood-control systems in a manner which will help preserve their natural settings (Policy 6).

The Proposed Project will eliminate erosion problems occurring within the project site by providing a shotcrete wall. The design of the wall will generally maintain the present alignment of Aiea Stream, and a natural-looking textured finish for the shotcrete wall will be used. In addition, the stream bed will be mostly unaffected by the Proposed Project.

2.3.4 Primary Urban Center Development Plan

The project site is located in the Primary Urban Center (PUC) planning area, which extends from Pearl City in the west to Waialae-Kahala in the east. The PUC Development Plan was adopted by the City Council on June 21, 2004. The plan noted the importance of managing urban watersheds to protect coastal water quality. Flood control and erosion control projects should recognize important aesthetic and ecological factors in their design process. For example, streams should not be channelized except when absolutely necessary to protect existing urban development from flooding. As noted above in Section 2.3.3, the Proposed Project will maintain present alignment of Aiea Stream and its stream bed, and use a natural-looking textured facing.

2.4 Permits and Approvals

The following environmental permits and approvals will be required prior to the construction of the project:

- USACE – CWA Section 404 permit (includes CZM program consistency)
- SDOH – CWA Section 401 Water Quality Certification
- DPP – Grading, Grubbing, Stockpiling and Excavation permit

CHAPTER 3
COMMENTS AND COORDINATION

This chapter summarizes the public and agency consultation and coordination activities associated with the Proposed Project. In addition to early agency consultation, this chapter also provides a record of all comments received during the Draft EA comment period.

3.1 Early Agency Consultation

The following federal, State of Hawaii and City and County of Honolulu agencies were contacted by letter dated October 20, 2009 (see Appendix A) and were asked if they were aware of any environmental or social issue associated with the Proposed Project, or if they had any environmental concerns. An asterisk appears next to those agencies that responded.

Federal Agencies
- U.S. Department of the Army, Corps of Engineers*

State of Hawaii Agencies
- Department of Business, Economic Development and Tourism, Office of Planning*
- Department of Defense*
- Department of Health, Environmental Health Administration* (Clean Water Branch responded)
- Department of Land and Natural Resources
  - Commission on Water Resource Management*
  - Division of Aquatic Resources
  - Division of Forestry and Wildlife
  - Land Division
  - State Historic Preservation Division*
- Office of Environmental Quality Control
- Office of Hawaiian Affairs

City and County of Honolulu Agencies
- Department of Design and Construction*
- Department of Emergency Management*
- Department of Environmental Services
- Department of Facility Maintenance*
- Department Planning and Permitting*
- Department of Transportation Services
- Honolulu Fire Department*
- Honolulu Police Department*

Copies of the responses are provided in the Appendix A. A brief summary of the comments are provided below.

The Army Corps of Engineers requested that the EA identify Aiea Stream's ordinary high water mark (see Section 2.1.2) and to note whether or not the project site contains wetlands.

The State Department of Business, Economic Development and Tourism, Office of Planning expressed concern about possible pollution from the project site affecting public recreation and marine life within the coastal receiving waters.

The State Department of Health, Clean Water Branch (CWB) noted that Aiea Stream is listed as a 303(d) water body and that the EA should discuss potential impacts to the stream's pollutant of concern (see Section 2.1.2). The CWB also stated that the Proposed Project must comply with the State water quality standards.

The State Department of Land and Natural Resources (DNLR) Commission on Water Resource Management stated that the Proposed Project does not require a Stream Channel Alteration Permit.

DNLR State Historic Preservation Division stated that the project site does not contain historic properties, meaning sites or resources on or eligible for the National or Hawaii Register of Historic Places.

The City Department of Planning and Permitting stated that project site is located in a floodway, and that a professional engineer should certify that Proposed Project will not affect the regulatory flood elevations (see Section 2.1.2).

The State Department of Defense, the City Department of Design and Construction, the City Department of Emergency Management, the City Department of Facility Maintenance, the Honolulu Fire Department and the Honolulu Police Department offered no comments.

In addition to the letters and comments received as a result of the October 20, 2009 solicitation, project staff conducted a meeting with representatives of Aiea Shopping Center on February 18, 2009. The project staff described the Proposed Project, and the shopping center representatives provided design plans of the center's buildings.

3.2 Draft Environmental Assessment

The Proposed Project's Draft EA was announced in the May 23, 2010 edition of the Environmental Notice, which initiated the 30-day public comment period that ended on June 22, 2010. Copies of the Draft EA were mailed to federal, State and City and County of Honolulu agencies that may have an interest in the project, and the Aiea Public Library. All parties that were sent copies of the Draft EA were asked to provide comments.

The following three agencies submitted comments on the Draft EA:

- State of Hawaii Department of Health
- City Department of Planning and Permitting
- City Department of Transportation Services
- City Department of Design and Construction

Copies of the comment letters and response letters from HDOT are provided in the Appendix A.

CHAPTER 4
FINDING OF NO SIGNIFICANT IMPACT

In accordance with the Hawaii Revised Statutes (HRS) Chapter 343 HRS and Hawaii Administrative Rules (HAR), Sections 11-200-9 and 11-200-11.2, HDOT Highways has issued a Finding of No Significant Impact (FONSI) for the Proposed Project. The FONSI is based on an evaluation of project impacts in relation to the "Significance Criteria" specified in HAR 11-200-12(b). The Significance Criteria appear below in italics, followed by a discussion of the project in relation to the specific criterion provided. The specifics regarding the project's potential impacts are discussed in detail in Chapter 2.

Involves an irrevocable commitment to loss or destruction of any natural or cultural resource – The project site does not contain important natural resources (see Section 2.1.3). In addition, the project site is within an intermittent natural stream channel subject to periodic storm water flows and the surrounding area has been subject to substantial construction and development. The project site is highly unlikely to contain cultural or archaeological resources.

Curtails the beneficial uses of the environment – The Proposed Project is meant to enhance the function of Aiea Stream by addressing erosion problems.

Conflicts with the State's long-term environmental policies or goals and guidelines expressed in Chapter 344, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders - The Proposed Project is consistent with the environmental goals and objectives of the State of Hawaii (see Section 2.3.1).

Substantially affects the economic or social welfare of the community or State – By stabilizing Aiea Stream's Ewa bank within the project site, the Proposed Project will contribute to protecting Aiea Shopping Center from erosion that could eventually adversely affect the structural integrity of the building.

Substantially affects public health – The Proposed Project will not change the flooding risks associated with Aiea Stream (see Section 2.1.2).

Involves substantial secondary impacts - The Proposed Project will not cause secondary impacts because the project will not factor into the land use decisions of landowners controlling adjacent and nearby properties (see Section 2.2.1).

Involves substantial degradation of environmental quality - The Proposed Project will maintain the existing contours and shape of Aiea Stream, and maintain the capacity of the stream to convey storm water.

Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions – The Proposed Project will not commit HDOT Highways or other entities to other actions at or near the project site.

Substantially affects a rare, threatened or endangered species, or its habitat – The project site does not contain rare, threatened or endangered plant or animal species (see Section 2.1.3).

Detrimentally affects air or water quality or ambient noise levels – The Proposed Project will not affect the quality of storm water conveyed within Aiea Stream (see Section 2.1.3). Once constructed, the Proposed Project will not emit air pollutants or cause noise propagation, except for periodic stream maintenance to clear vegetation and debris, which may require handheld gasoline-powered equipment. This same type of maintenance would also occur under the No Build alternative.

Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a floodplain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters - The project site is not located in an environmentally sensitive area (see above).

Substantially affects scenic vistas and viewplanes identified in county or state plans or studies – Aiea Stream is relatively inconspicuous, and is not featured as a prominent visual resource by surrounding land uses. The Proposed Project will not change this condition. Up close, the appearance of the Ewa bank will change from bare rock and soils and tree roots to a shotcrete wall with textured surface facing (see Section 2.1.5). Rather than a retaining wall, the shotcrete wall will provide a natural looking façade and maintain the present alignment of the stream.

Requires substantial energy consumption – Following construction, the Proposed Project does not require the consumption of energy, except for periodic maintenance, which would also occur under the No Build alternative.

CHAPTER 5
REFERENCES

Aiea Hongwanji Mission website <http://www.webspawner.com/users/AieaHongwanji>

City and County of Honolulu, Revised Ordinances of Honolulu

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VTN Pacific for the City and County of Honolulu, Department of Public Works, Aiea Stream Flood Control, Revised Environmental Impact Statement, July 14, 1977

Appendix A

Agency and Stakeholder Letters

Appendix B

Hydrologic and Hydraulics Report

Appendix C

Aiea Stream Field Report

LINDA LINGLE
GOVERNOR OF HAWAII

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

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PARSONS BRINCKERHOFF
HONOLULU, HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801-3378

In reply, please refer to:
EMD / CWB

06017PKP.10

June 7, 2010

Mr. Richard Dahilig, P.E.
Project Manager
PB Americas, Inc.
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

Dear Mr. Dahilig:

Subject: Comments on the Draft Environmental Assessment (Draft EA) for the Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway Aiea, Island of Oahu, Hawaii TMKs: (1) 9-9-042:027

The Department of Health (DOH), Clean Water Branch (CWB) has reviewed the subject document and has no comments at this time. The DOH-CWB provided comments on this project (Letter No. 11007CEC.09, dated November 4, 2009).

As a reminder, all discharges related to the project construction or operation activities, whether or not National Pollutant Discharge Elimination System permit coverage and/or Section 401 Water Quality Certification are required, must comply with the Water Quality Standards. Noncompliance with water quality requirements contained in HAR, Chapter 11-54, and/or permitting requirements, specified in HAR, Chapter 11-55, may be subject to penalties of $25,000 per day per violation.

If you have any questions, please visit our website at http://www.hawaii.gov/health/environmental/water/cleanwater/index.html, or contact the Engineering Section, CWB, at 586-4309.

Sincerely,

Alec Wong

ALEC WONG, P.E., CHIEF
Clean Water Branch

KP:ml

c: DOH-EPO #I-3203 [via email only]
Mr. Emilio Barroga, HWY-DS

PB Americas, Inc.
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, HI 96813
808-531-7094
Fax: 808-528-2368

July 7, 2010

Mr. Alec Wong, P.E., Chief
State of Hawaii
Department of Health
Clean Water Branch
P.O. Box 3378
Honolulu, Hawaii 96801-3378

SUBJECT: Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
Aiea, Hawaii, Project No. H1E-01-09

Dear Mr. Wong,

Thank you very much for your comments on the Draft Environmental Assessment (EA) prepared for the subject project. A copy of your comment letter is attached.

Your only comment is that the project must comply with the State Water Quality Standards, as specified in Chapter 11-54 of the Hawaii Revised Statutes (HRS). Since the project will require a water quality certification pursuant to Section 401 of the federal Clean Water Act, the Highways Division of the Hawaii Department of Transportation (HDOT) is committing to prepare and implement a best management practices plan and will arrange for water quality monitoring in accordance with Department of Health requirements.

HDOT has completed the environmental review of the project in accordance with HRS Chapter 343 and will be issuing a Finding of No Significant Impact.

If you have any questions or require additional information, please do not hesitate to call me at 566-2209.

Very truly yours,
PB AMERICAS INC.

Richard Dahilig

Richard Dahilig, P.E.
Project Manager

cc. Emilio Barroga, HWY-DS
Robert Shin, HWY-OC

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

MUFI HANNEMANN
MAYOR

DAVID K. TANOUE
DIRECTOR

ROBERT M. SUMITOMO
DEPUTY DIRECTOR

RECEIVED
JUN 2 2 2010
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

June 21, 2010

2010/ELOG-1115 (df)

Mr. Richard Dahilig
PB Americas, Inc.
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

Dear Mr. Dahilig:

Subject: April 26, 2010 Draft Environmental Assessment (DEA) for
Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway,
Tax Map Key: 9-9-042: 027 and 059

This is in response to your May 26, 2010 letter, requesting our review and comments to the subject document. Our comments are as follows:

1. According to records obtained from the Department of Design and Construction, Land Division, it appears that the project will be situated within existing drainage and maintenance easements that are in favor of the City. Please consult with the Department of Facility Maintenance regarding any comments or concerns that they may have regarding the proposed project.

2. The final environmental assessment (FEA) should state that the project is located within the AE floodway district. Also, please note that a licensed professional engineer **SHALL** certify that the project will not result in any increase of the regulatory flood elevations (Refer to Page 3-2).

3. Our staff contacted Emilio Barroga of the State Department of Transportation (DOT) by phone on June 2, 2010, and was told that pursuant to an agreement with the DOT, the property owner of TMK: 9-9-042: 059 will assume responsibility for maintaining, repairing and replacing the proposed improvement. Please consult with Mr. Barroga for inclusion of this informational item in the Final Environmental Assessment.

4. Chapter 5, References: This chapter should include the "*Rules Relating to Storm Drainage Standards, January 2000*" and "*Rules Relating to Soil Erosion Standards and Guidelines, April 1999*" as references.

5. The 100-year discharge based on the drainage area at the proposed site (FIRM study) should be used and the impacts of the proposed action be compared to the existing 100-year water surface elevation.

6. No rise calculations will need to reflect zero rise in the water surface elevations. Increases of .01 and .02 feet are not acceptable.

7. Was the lifecycle cost of shotcrete versus a concrete channel considered in the selection of the erosion alternatives? Shouldn't the alternatives include estimated costs to repair and maintain the channel from damage due to potential impact forces exerted on the wall? Was erosion a result of high velocity flows or was it a combination of debris and high velocity?

If there are any questions, please contact Mr. Don Fujii of the Site Development Division at 768-8107.

Very truly yours,

for David K. Tanoue, Director
Department of Planning and Permitting

DKT:ky
[774709]

cc: Department of Facility Maintenance
Department of Transportation, Highways Division

PB Americas, Inc.
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, HI 96813
808-531-7094
Fax: 808-528-2368

July 7, 2010

Mr. David K. Tanoue, Director
City and County of Honolulu
Department of Planning and Permitting
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

SUBJECT: Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
Aiea, Hawaii, Project No. H1E-01-09

Dear Mr. Tanoue,

Thank you very much for your comments on the Draft Environmental Assessment (EA) prepared for the subject project. A copy of your comment letter is attached. We would like to provide the following responses to these comment by number indicated in your letter.

1. We are aware that the Department of Facility Maintenance (DFM) has maintenance responsibilities for Aiea Stream. As the project moves to final design, the Highways Division of the Hawaii Department of Transportation (HDOT) will contact DFM to discuss stream maintenance issues, if any. Also, please see our response to comment 3.

2. The Draft EA disclosed that the project site is within the regulatory floodway, but it did not disclose the precise zone (AE). The zone will be disclosed in the Final EA. The results of the hydraulic modeling shall be independently reviewed and certified by a licensed engineer.

3. HDOT is planning to form an agreement with the Aiea Shopping Center (TMK 9-9-042:059) owners regarding easements and maintenance responsibilities. In coordination with DFM, HDOT is planning to require that the shopping center owners become responsible for maintaining the new shotcrete wall. As noted in our response to comment 7, the maintenance needs of the wall should be minimal.

4. As requested, the references will be added to Chapter 5 of the EA.

5. The 100-year discharge was based on the hydrological study prepared for this project (please see Appendix B of the EA). This discharge was compared with and found to be consistent with the 100-year discharge of the FIRM hydrologic analysis.

6. The sections of Aiea Stream where the hydraulic modeling shows floodwater elevations that are 0.01 to 0.02 feet above existing conditions are located upstream of the Ulune Street culvert. These results were caused by model sensitivities, not because of the proposed project, which will be located downstream of the H-1 Freeway culvert. The

Ulune Street culvert is upstream of a steep spillway at the inlet (upstream) of the H-1 Freeway culvert. In all other sections along the study area of the hydraulic modeling, floodwater elevations are predicted to be the same or lower than existing conditions.

7. The shotcrete wall will have the same compressive strength, 4,000 pounds per square inch, as a concrete U-shaped channel. As described in the EA, a U-shaped channel was considered as an alternative, but was not selected because of its high cost and greater environmental impacts. However, either the shotcrete wall or the U-shaped channel will prevent erosion along the Ewa bank of Aiea Stream in the vicinity of Aiea Shopping Center. Due to the 4,000 psi compressive strength of the shotcrete wall, maintenance of the wall will be minimal. High velocity flows have been the primary cause of erosion with debris as a secondary cause.

HDOT has completed the environmental review of the project in accordance with HRS Chapter 343 and will be issuing a Finding of No Significant Impact.

If you have any questions or require additional information, please do not hesitate to call me at 566-2209.

Very truly yours,
PB AMERICAS, INC.

Richard Dahilig

Richard Dahilig, P.E.
Project Manager

cc: Emilio Barroga, HWY-DS
Robert Shin, HWY-OC

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 3RD FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8305 • Fax: (808) 768-4730 • Internet: www.honolulu.gov

MUFI HANNEMANN
MAYOR

WAYNE Y. YOSHIOKA
DIRECTOR

SHARON ANN THOM
DEPUTY DIRECTOR

KENNETH TORU HAMAYASU
DEPUTY DIRECTOR

TP6/10-369987R

June 28, 2010

RECEIVED
JUN 29 2010
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

Mr. Richard Dahilig, P.E.
PB Americas, Inc
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

Dear Mr. Dahilig:

Subject: Draft Environmental Assessment (DEA)
Aiea Stream Erosion Control
Tax Map Key: 9-9-042: 027 and 059

This responds to your letter of June 7, 2010, requesting our review and comments on the subject project. Based on our review, we have no comments to offer. However, we suggest that the affected Neighborhood Board, residents, and businesses are informed and updated about the scope and duration of the project.

Thank you for the opportunity to review this matter.

Should you have any further questions on the matter, you may contact Ms. Virginia Bisho of my staff at 768-5461.

Very truly yours,

WAYNE Y. YOSHIOKA
Director

cc: Mr. Emilio Barroga
State Department of Transportation,
Highways Division

PB Americas, Inc.
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, HI 96813
808-531-7094
Fax: 808-528-2368

July 7, 2010

Mr. Wayne Yoshioka
City and County of Honolulu
Department of Transportation Services
650 South King Street, 3rd Floor
Honolulu, Hawaii 96813

SUBJECT: Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
Aiea, Hawaii, Project No. H1E-01-09

Dear Mr. Yoshioka,

Thank you very much for your comments on the Draft Environmental Assessment (EA) prepared for the subject project. A copy of your comment letter is attached.

You suggested that we contact the Aiea Neighborhood Board and nearby residents and businesses. In developing this project, we have been working closely with representatives of Aiea Shopping Center and we will be contacting the residents in the immediate vicinity of the project site.

The Hawaii Department of Transportation, Highways Division has completed the environmental review of the project in accordance with HRS Chapter 343 and will be issuing a Finding of No Significant Impact.

If you have any questions or require additional information, please do not hesitate to call me at 566-2209.

Very truly yours,
PB AMERICAS, INC.

Richard Dahilig

Richard Dahilig, P.E.
Project Manager

cc: Emilio Barroga, HWY-DS
Robert Shin, HWY-OC

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 768-4567
Web site: www.honolulu.gov

MUFI HANNEMANN
MAYOR

CRAIG I. NISHIMURA, P.E.
DIRECTOR

COLLINS D. LAM, P.E.
DEPUTY DIRECTOR

July 1, 2010

RECEIVED
JUL 6 2010
PARSONS BRINCKERHOFF
HONOLULU

Mr. Richard Dahilig
PB Americas, Inc.
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

Dear Mr. Dahilig:

Subject: Draft Environmental Assessment (Draft EA) for Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway

Thank you for inviting us to review the above Draft Environmental Assessment. The Department of Design and Construction has the following comments to offer:

- Who will be responsible for the maintenance of the improvements upon completion of the project?

- According to hydraulic calculations that were provided, the proposed improvements in the stream will increase the velocity to more than double its existing velocity just downstream of the project limits (Sta. 304+44). It appears that this would create an erosion problem downstream of the project limits. Also, just downstream of the project limits is an existing sharp bend going in the other direction from the bend at the project limits. How will hardening of the bend in your project limits impact the bend downstream?

Should you have any questions, please contact Marvin Char at 768- 8826.

Very truly yours,

Collins D. Lam
FOR Craig I. Nishimura, P.E.
Director

CN:pg(370011)

PB Americas, Inc.
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, HI 96813
808-531-7094
Fax: 808-528-2368

July 7, 2010

Mr. Craig I Nishimura, P.E., Director
City and County of Honolulu
Department of Design and Construction
650 South King Street, 11th Floor
Honolulu, Hawaii 96813

SUBJECT: Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway
Aiea, Hawaii, Project No. H1E-01-09

Dear Mr. Nishimura,

Thank you very much for your comments on the Draft Environmental Assessment (EA) prepared for the subject project. A copy of your comment letter is attached. We would like to provide the following responses to the two comments you provided.

1. The Department of Facility Maintenance currently has a maintenance easement within the stream. This will not change after construction. The Highways Division of the Hawaii Department of Transportation (HDOT) is planning to form an agreement with the Aiea Shopping Center owners regarding construction easements, and maintenance responsibilities. In coordination with DFM, HDOT is planning to require that the shopping center owners become responsible for maintaining the new wall.

2. We do not anticipate erosion problems outside of the project site, including where the stream bends right shortly downstream from the project site. Our HEC-RAS 4.0 modeling results indicate the project will not change 100-year flood water surface elevations and flow velocities as compared to existing conditions along both banks where the stream bends (stations 303+93 and 303+59).

HDOT has completed the environmental review of the project in accordance with HRS Chapter 343 and will be issuing a Finding of No Significant Impact.

If you have any questions or require additional information, please do not hesitate to call me at 566-2209.

Very truly yours,
PB AMERICAS, INC.

Richard Dahilig

Richard Dahilig, P.E.
Project Manager

cc: Emilio Barroga, HWY-DS
Robert Shin, HWY-OC

PB Americas, Inc.
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, HI 96813
808-531-7094
Fax: 808-528-2368

October 20, 2009

See enclosed list.

Subject: Proposed Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway Aiea, Hawaii

The State of Hawaii Department of Transportation (HDOT) is proposing to mitigate (correct) erosion problems occurring along Aiea Stream immediately downstream of the H-1 Freeway. In particular, erosion is affecting the foundation of the Aiea Shopping Center. The eroded stream bank requires protection and strengthening to prevent further undercutting. The proposed project would stabilize approximately 200 linear feet of stream bank by soil nailing with shotcrete facing. A project location map is enclosed.

PB Americas, Inc. was contracted to assist HDOT in preparing an Environmental Assessment (EA) for this project in accordance with Chapter 343 of the Hawaii Revised Statutes. If you have knowledge of any environmental issue associated with this project, we would appreciate this information. Also, please let us know if you have any concerns regarding this project so we can address them in the EA. Please provide any comments by November 30, 2009.

Please do not hesitate to call me at 808-566-2209 or e-mail at Dahilig@pbworld.com if you have any questions.

Sincerely yours,
PB Americas, Inc.

Richard Dahilig

Richard Dahilig, P.E.
Project Manager

Enclosure: Project Location Map

cc: Robert Shin, Hawaii Department of Transportation, Highways Division

List of Agencies Receiving Request for Comments Letter

Mr. George P. Young
Chief
U.S. Department of the Army
Corps of Engineers
Regulatory Branch

Ms. Abbey S. Mayer
Director
State of Hawaii
Department of Business, Economic
Development and Tourism
Office of Planning

Major General Robert G.F. Lee
Adjutant General
State of Hawaii
Department of Defense

Mr. Laurence K. Lau, Esq.
Deputy Director
State of Hawaii
Department of Health
Environmental Health Administration

Mr. Morris Atta
Administrator
State of Hawaii
Department of Land and Natural Resources
Land Division

Mr. Laura H. Thielen
Chairperson
State of Hawaii
Department of Land and Natural Resources
Commission on Water Resource Management

Ms. Pua Aiu
Administrator
State of Hawaii
Department of Land and Natural Resources
State Historic Preservation Division

Mr. Dan Polhemus
Administrator
State of Hawaii
Department of Land and Natural Resources
Division of Aquatic Resources

Mr. Paul Conry
Administrator
State of Hawaii
Department of Land and Natural Resources
Division of Forestry and Wildlife

Ms. Katherine Puana Kealoha, Esq.
Director
State of Hawaii
Office of Environmental Quality Control

Mr. Craig I. Nishimura, P.E.
Acting Director
City & County of Honolulu
Department of Design and Construction

Mr. Melvin Kaku
Director
City & County of Honolulu
Department of Emergency Management

Mr. Tim Steinberger
Director
City & County of Honolulu
Department of Environmental Services

Mr. Jeoffrey S. Cudiamat, P.E.
Director and Chief Engineer
City & County of Honolulu
Department of Facility Maintenance

Mr. David K. Tanoue
Director
City & County of Honolulu
Department of Planning and Permitting

Mr. Wayne Yoshioka
Director
City & County of Honolulu
Department of Transportation Services

Mr. Kenneth G.Silva
Fire Chief
Honolulu Fire Department

Mr. Boisse Correa
Police Chief
Honolulu Police Department

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

October 29, 2009

Regulatory Branch

File Number: POH-2009-312

Richard Dahilig, Project Manager
PB Americas, Inc.
American Savings Bank Tower
1001 Bishop St., Suit 2400
Honolulu, HI 96813

Dear Mr. Dahilig:

This letter is in response to your request, dated October 20, 2009, for early consultation comments for the proposed Aiea Stream erosion control project located immediately downstream of the H-1 Freeway, Aiea, Oahu, Hawai'i.

We recommend your Draft Environmental Assessment (DEA) provide a detailed description of all ground-disturbing activities associated with the project occurring on and in the immediate vicinity of the project site; provide a cross-section of the proposed work and the existing conditions at the proposed project location; describe the flow characteristics (i.e., volume, duration, etc.) and identify the ordinary high water mark (OHWM) for Aiea Stream [as described at 33 CFR 328.3 (e)]; and identify any wetlands on and in the immediate vicinity of the proposed project site using the procedures set forth in the Army Corps of Engineers' 1987 *Wetland Delineation Manual.*

Section 404 of the Clean Water Act (Section 404) requires that a Department of Army (DA) permit be obtained for the discharge (placement) of dredge and/ or fill material into waters of the U.S., including jurisdictional wetlands (33 U.S.C. 1344). The Corps defines wetlands as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions.

Please include the aforementioned in your DEA and submit to our office for review and permit decision. If you have any questions, please contact Ms. Meris Bantilan-Smith, of my Regulatory staff at 808-438-7023 or by electronic mail at Meris.Bantilan-Smith@usace.army.mil. Please include File No. POH-2009-312 in any future correspondence regarding this project. Please be advised you can provide comments on your experience with the Corps' Honolulu District Regulatory Branch by accessing our web-based customer survey form at http://per2.nwp.usace.army.mil/survey.html.

Sincerely,

George P. Young, P.E.
Chief, Regulatory Branch

From: Douglas Tom [mailto:DTom@dbedt.hawaii.gov]
Sent: Wednesday, October 21, 2009 11:26 AM
To: Dahilig, Richard C. V.
Subject: Proposed Aiea Stream Erosion Control Project

In the preparation of the EA or EIS, we believe it is important to include a complete assessment of the project relative to the Coastal Zone Management (CZM) objectives and policies of Chapter 205A, Hawaii Revised Statutes, since the entire state is situated within the CZM area and all activities are obligated to consistent with and in compliance with CZM. This is important since the project relates to water movement. Under the Coastal Nonpoint Pollution Control Program, both CZM and the Department of Health are responsible for dealing with polluted runoff, assuring that it is prevented or at least minimized, with best management practices in place as appropriate or necessary. Moreover, we are concerned about the possible adverse impacts of the polluted flow on the coastal receiving waters and the effects on public recreation and marine life. We look forward to reviewing the prepared document at which time we may have specific comments and suggestions to offer. In the meantime, I strongly recommend you to review the Hawaii Ocean Resources Management Plan (ORMP). The DOT's Harbor Division is a member of the ORMP Working Group and may provide some assistance. The document is available on our CZM website and may be downloaded.

LINDA LINGLE
GOVERNOR

MAJOR GENERAL ROBERT G. F. LEE
DIRECTOR OF CIVIL DEFENSE

EDWARD T. TEIXEIRA
VICE DIRECTOR OF CIVIL DEFENSE

PHONE (808) 733-4300
FAX (808) 733-4287

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE DIRECTOR OF CIVIL DEFENSE
3949 DIAMOND HEAD ROAD
HONOLULU, HAWAII 96816-4495

November 3, 2009

Mr. Richard Dahilig, P.E.
Project Manager
PB Americas, Inc.
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

Dear Mr. Dahilig:

Proposed Aiea Stream Erosion Control

Thank you for the opportunity to comment on this project. After reviewing the documents you sent for this project, we have no early consultation comments to make. We look forward to reviewing the Environmental Assessment when it is completed.

If you have any questions, please call Ms. Havinne Okamura, State Civil Defense Hazard Mitigation Planner, at (808) 733-4300, ext. 556.

Sincerely,

EDWARD T. TEIXEIRA
Vice Director of Civil Defense

LINDA LINGLE
GOVERNOR OF HAWAII

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

In reply, please refer to:
DOH/CWB

11007CEC.09

November 4, 2009

Mr. Richard Dahilig, P.E.
Project Manager
PB Americas, Inc.
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

Dear Mr. Dahilig:

SUBJECT: Early Consultation Comments for the Preparation of a Draft Environmental Assessment (DEA) for Stabilization of a Section of Aiea Stream Bank Immediately Downstream of the H-1 Freeway Island of Oahu, Hawaii

The Department of Health (DOH), Clean Water Branch (CWB), acknowledges receipt of your letter, dated October 20, 2009, to Mr. Laurence K. Lau, Deputy Director for Environmental Health, requesting early consultation comments for the subject project in accordance with Hawaii Revised Statutes (HRS), Chapter 343.

1. The DOH, Office of Environmental Quality Control (OEQC) administers HRS, Chapter 343, through the implementation of Hawaii Administrative Rules (HAR), Chapter 11-200 (Environmental Impact Statement Rules). Please contact the DOH, OEQC at the address below:

   Office of Environmental Quality Control
   235 South Beretania Street, Suite 702
   Honolulu, Hawaii 96813
   Ph. 586-4185
   Fax. 586-4186
   E-mail: oeqc@doh.hawaii.gov

2. The DOH-CWB administers HAR, Chapters 11-54 and 11-55. We recommend that you read our standard comments on our website at: http://hawaii.gov/health/environmental/env-planning/landuse/landuse.html/CWB-standardcomment.pdf.

3. Aiea Stream is identified in DOH's "**2006 STATE OF HAWAII WATER QUALITY MONITORING AND ASSESSMENT REPORT**" dated January 11, 2008, as Water Quality-Limited Segment in accordance with Federal Clean Water Act, Subsection 303(d). Pollutants of concerns (POC) for the entire stream network as listed in Chapter IV (Assessment Table, Page 9) are Total Nitrogen, Nitrate & Nitrite Nitrogen (NO_3+NO_2), Turbidity and trash for both dry and wet seasons. The DEA should properly address whether the construction (by soil nailing with shotcrete facing) or operation of the proposed 200 linear feet bank stabilization activities would cause the net increase of loadings of POC.

4. Please note that all discharges related to the project construction or operation activities, whether or not National Pollutant Discharge Elimination System permit coverage and/or Section 401 Water Quality Certification are required, must comply with the Water Quality Standards. Noncompliance with water quality requirements contained in HAR, Chapter 11-54, and/or permitting requirements, specified in HAR, Chapter 11-55, may be subject to penalties of $25,000 per day per violation.

Should you have any questions, please also visit our website at http://www.hawaii.gov/health/environmental/water/cleanwater/index.html, or contact the Engineering Section, CWB, at 586-4309.

Sincerely,

ALEC WONG, P.E., CHIEF
Clean Water Branch

EC:np

c: Regulatory Branch, HED [via fax 438-4060 only]
CZM Program, Office of Planning, DBEDT [via fax 587-2899 only]
CWRM, DLNR [via e-mail Robert.K.Chong@hawaii.gov only]

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON

WILLIAM D. BALFOUR, JR.
SUMNER ERDMAN
NEAL S. FUJIWARA
CHIYOME L. FUKINO, M.D.
DONNA FAY K. KIYOSAKI, P.E.
LAWRENCE H. MIIKE, M.D., J.D.

KEN C. KAWAHARA, P.E.
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P.O. BOX 621
HONOLULU, HAWAII 96809

October 26, 2009

Ref.: RFD.2507.3

Mr. Richard Dahilig, P.E., Project Manager
PB Americas, Inc.
1001 Bishop Street, Suite 2400
Honolulu, HI 96813

Dear Mr. Dahilig:

Request for Determination
Proposed Aiea Stream Erosion Control at the H-1 Freeway
Aiea, Oahu, TMKs: (1) 9-9-042:027 and 059

This letter is in response to your October 20, 2009, letter to the Commission on Water Resource Management (Commission) requesting a determination for the proposed Aiea Stream Erosion Control Project at the H-1 freeway in Aiea, Oahu at TMKs: (1) 9-9-042:027 and 059.

The Commission's Stream Protection and Management Branch has the responsibility to protect stream channels from alteration whenever practicable to provide for fishery, wildlife, recreational, aesthetic, scenic, and other beneficial instream uses in the State of Hawaii under the authorization of the State Water Code (Code), Chapter 174C, Hawaii Revised Statutes, and Chapter 13-169, Hawaii Administrative Rules (Protection of Instream Uses of Water).

Pursuant to the Code, §174C-71(3)(A), the Commission "shall require persons to obtain a permit from the Commission prior to undertaking a stream channel alteration." The term "stream channel" is defined in the Code, §174C-3, as a "watercourse with a definite bed and banks which periodically or continuously contains flowing water." Furthermore, the Code defines "stream" as any "natural watercourse in which water usually flows in a defined bed or channel."

Based on the information that you provided, the Commission will not require a Stream Channel Alteration Permit (SCAP) to be submitted for the proposed Aiea Stream Erosion Control Project because Aiea Stream is considered an intermittent stream where aquatic resources have not been identified.

Please be advised that the project may require other agency approvals regarding wetlands, water quality, grading, stockpiling, and floodways. This letter should not be used for other regulatory jurisdictions or used to imply compliance with other federal, state, or county rules. Should you have any questions, please contact Robert Chong of the Stream Protection and Management Branch at 587-0266, or robert.k.chong@hawaii.gov.

Sincerely,

KEN C. KAWAHARA, P.E.
Deputy Director

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RUSSELL Y. TSUJI
FIRST DEPUTY

KEN C. KAWAHARA
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

November 4, 2009

Richard Dahilig, P.E.
PB Americas Inc
1001 Bishop Street, Suite 2400
Honolulu, Hawai'i 96813

LOG NO: 2009.4483
DOC NO: 0911NM06
Archaeology

Dear Mr. Dahilig:

SUBJECT: **Chapter 6E-8 Historic Preservation Review –**
Environmental Assessment— Early Consultation
Aiea Intermediate School Erosion Control Project DOE Job No. Q71009-07
Aiea Ahupua'a, Ewa District, Oahu, Hawai'i
TMK: (1) 9-9-005: 001

Thank you for providing the opportunity to comment on Environmental Assessment which we received on October 21, 2009. We concur that there will be **"no historic properties affected"** by this project since an archaeological assessment was conducted by Cultural Surveys Hawaii and no historic properties were found although they did recommend archaeological monitoring.

Please contact me at (808) 692-8015 if you have any questions or concerns regarding this letter.

Aloha,

Nancy A. McMahon (Deputy SHPO)
Archaeology and Historic Preservation Manager

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 768-4567
Web site: www.honolulu.gov

MUFI HANNEMANN
MAYOR

CRAIG I. NISHIMURA, P.E.
DIRECTOR

COLLINS D. LAM, P.E.
DEPUTY DIRECTOR

November 2, 2009

Mr. Richard Dahilig, P.E.
PB Americas, Inc.
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

Dear Mr. Dahilig:

Subject: Proposed Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway Aiea, Hawaii

Thank you for inviting us to review the above Environmental Assessment. The Department of Design and Construction does not have any comments to offer at this time.

Should you have any questions, please contact Craig Nishimura, Director, at 768-8480.

Very truly yours,

Collins D. Lam

FOR Craig I. Nishimura, P.E.
Director

CN:pg(338472)

DEPARTMENT OF EMERGENCY MANAGEMENT
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

Mufi Hannemann
MAYOR

Melvin N. Kaku
DIRECTOR

October 30, 2009

Mr. Richard Dahilig, P.E.
Project Manager
PB Americas, Inc.
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96797

Dear Mr. Dahilig:

Subject: Proposed Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway - Aiea, Hawaii

Thank you for the opportunity to provide comments on the proposed Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway, Aiea, Hawaii. The Department of Emergency Management does not have any knowledge of any environmental issues associated with this project, nor do we have any comments at this time.

Sincerely,

Melvin N. Kaku
Director

DEPARTMENT OF FACILITY MAINTENANCE

CITY AND COUNTY OF HONOLULU

1000 Ulu`ohia Street, Suite 215, Kapolei, Hawaii 96707
Phone: (808) 768-3343 • Fax: (808) 768-3381
Website: www.honolulu.gov

MUFI HANNEMANN
MAYOR

JEOFFREY S. CUDIAMAT, P. E.
DIRECTOR AND CHIEF ENGINEER

GEORGE "KEOKI" MIYAMOTO
DEPUTY DIRECTOR

IN REPLY REFER TO:

November 30, 2009

Mr. Richard Dahilig
Project Manager
PB Americas, Inc.
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

RE: 'Aiea Stream Erosion Control Project (Aiea Shopping Center)

Dear Mr. Dahilig:

Thank you for the opportunity for early consultation on the proposed subject project. We reviewed the location of the project and the proposed methods for repairing eroded areas and stabilizing the bank from further erosion. We have no preliminary comments at this time.

Should you have any questions, please contact Lynel Rabago, at 768-3375.

Sincerely,

Jeoffrey S. Cudiamat, P. E.
Director and Chief Engineer

JSC/lr

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

MUFI HANNEMANN
MAYOR

DAVID K. TANOUE
DIRECTOR

ROBERT M. SUMITOMO
DEPUTY DIRECTOR

November 16, 2009

2009/ELOG-2558 (df)

Mr. Richard Dahilig, P.E., Project Manager
PB Americas, Inc.
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

Dear Mr. Dahilig:

Subject: Draft Environmental Assessment (DEA) Preparation Notice for Aiea Stream Erosion Control in the Vicinity of the Interstate H-1 Freeway, Aiea
Tax Map Key: 9-9-042: 059

This is in response to your October 20, 2009 letter requesting our department's input to the subject project. Our preliminary comments are as follows:

1. According to the FEMA Flood Insurance Rate Map (FIRM), it appears that the project is located within the AE floodway district. A licensed professional engineer shall certify that the project will not result in any increase of the regulatory flood elevations.

2. A Stream Channel Alteration Permit may be required. We suggest you consult with the State Department of Land and Natural Resources, Commission on Water Resource Management.

If there are any questions, please contact Mr. Don Fujii of the Site Development Division at 768-8107.

Very truly yours,

David K. Tanoue, Director
Department of Planning and Permitting

DKT:ky
[732331]

HONOLULU FIRE DEPARTMENT

CITY AND COUNTY OF HONOLULU

636 South Street
Honolulu, Hawaii 96813-5007
Phone: 808-723-7139 Fax: 808-723-7111 Internet: www.honolulu.gov/hfd

MUFI HANNEMANN
MAYOR

KENNETH G. SILVA
FIRE CHIEF

ALVIN K. TOMITA
DEPUTY FIRE CHIEF

November 9, 2009

Mr. Richard Dahilig, P.E.
Project Manager
PB Americas, Inc.
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

Dear Mr. Dahilig:

Subject: Proposed Aiea Stream Erosion Control

In response to your letter dated October 20, 2009, regarding the above-mentioned subject, the Honolulu Fire Department reviewed the material provided and has no objections to the project.

Should you have any questions, please call Battalion Chief Socrates Bratakos of our Fire Prevention Bureau at 723-7151.

Sincerely,

KENNETH G. SILVA
Fire Chief

KGS/SY:jl

POLICE DEPARTMENT
CITY AND COUNTY OF HONOLULU
801 SOUTH BERETANIA STREET · HONOLULU, HAWAII 96813
TELEPHONE: (808) 529-3111 · INTERNET: www.honolulupd.org

MUFI HANNEMANN
MAYOR

PAUL D. PUTZULU
ACTING CHIEF

KARL A. GODSEY
DEPUTY CHIEF

OUR REFERENCE BS-DK

October 23, 2009

Mr. Richard Dahilig, P.E.
PB Americas, Inc.
1001 Bishop Street, Suite 2400
Honolulu, Hawaii 96813

Dear Mr. Dahilig:

This is in response to your letter of October 20. 2009, requesting comments on a proposal to mitigate erosion problems occurring along Aiea Stream, immediately downstream of the H-1 Freeway.

The Honolulu Police Department has no comments to offer at this time.

If there are any questions, please call Major Dave Kajihiro of District 3 at 723-8803 or Mr. Brandon Stone of the Executive Bureau at 529-3644.

Sincerely,

PAUL PUTZULU
Chief of Police

ACTING ASSISTANT CHIEF
S. THOMPSON, FOR

By
DEBORA A. TANDAL
Assistant Chief of Police
Support Services Bureau

Serving and Protecting With Aloha

APPENDIX 1

Aiea Stream Project Location Map

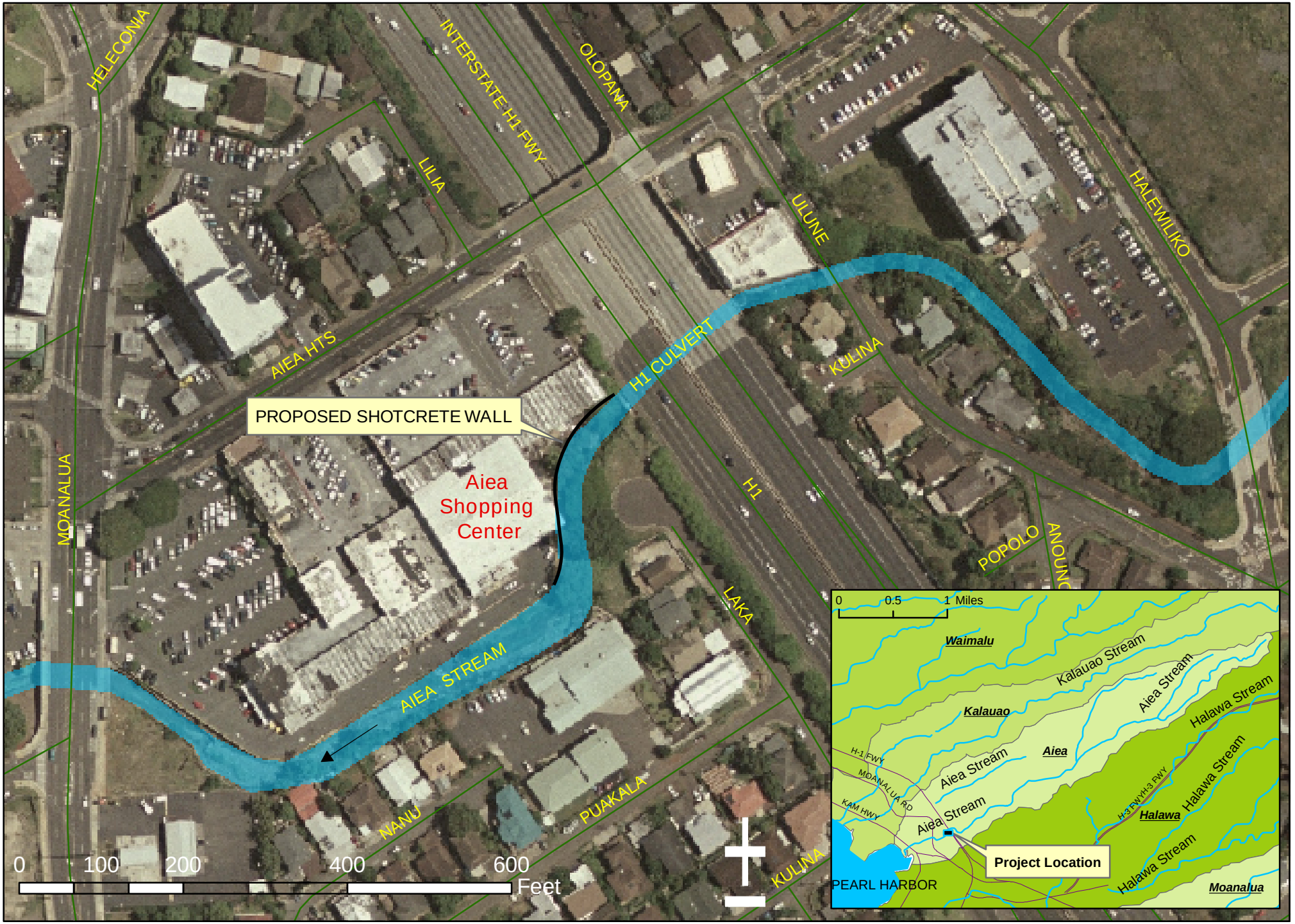


Figure 1. Project Location Map.

APPENDIX 2

Time of Concentration

Time of Concentration (Tc) or Travel Time (Tt)

Project	By Shirshant Sharma	Date 3-Sep-09
Location	Checked Justin Lennon	Date 3-Sep-09

Check one: ☑ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subareas

Notes: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to Tc only)

Segment ID						
1. Surface description	Short grass prairie		Fallow			
2. Mannings roughness coefficient, n	0.15		0.05			
3. Flow length, L ft	150					
4. Two-year 24-hour rainfall, P_2 in	4.32					
5. Landslope, s ft\ft	0.25					
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute Tt	0.0708	+	0.0000	=	0.0708	

Shallow concentrated flow

Segment ID						
7. Surface description (paved or unpaved)	Unpaved					
8. Flow length, L ft	233					
9. Watercourse slope, s ft\ft	0.5					
10. Average velocity, v ft\s	11.4088		0.0000			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	0.0057	+	0.0000	=	0.0057	

Channel Flow

Segment ID						
12. Cross sectional flow area, a ft^2	75					
13. Wetted perimeter, p_w ft	18					
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft	4.1667		0			
15. Channel slope, s ft\ft	0.02					
16. Mannings roughness coefficient, n	0.07					
17. Flow length, L ft	19552.4					
18. $V = \frac{1.49\,r^{2\backslash3}\,s^{1\backslash2}}{n}$ Compute V ft/s	7.7208		0.0000			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	0.7035	+	0.0000	=	0.7035	
20. Watershed or subareas Tc or Tt (add Tt in steps 6, 11, and 19) Hr					0.7799	

APPENDIX 3

Curve Number

Curve Number

Area (sq. ft)	CN Values	Percent of Area	Weighted CN	Soil Types and Area (sq. ft)			
				A	B	C	D
4.433893265	80	0.00%	9.31765E-06			4.433893	
6.960372374	91	0.00%	1.66382E-05			6.960372	
429.3580006	91	0.00%	0.001026343			429.358	
1.308189315	70	0.00%	2.40547E-06		1.308189		
2.239458389	80	0.00%	4.70613E-06			2.239458	
14645267.41	77	38.47%	29.62234447				14645267
17102.06093	77	0.04%	0.034591594				17102.06
67402.86553	85	0.18%	0.150497291				67402.87
27.21947428	77	0.00%	5.50556E-05				27.21947
339089.0914	92	0.89%	0.819469969				339089.1
42132.38971	94	0.11%	0.104034011				42132.39
517711.4669	85	1.36%	1.155947491				517711.5
40075.21536	85	0.11%	0.089480044				40075.22
237355.4102	85	0.62%	0.529967769				237355.4
5719021.152	77	15.02%	11.56761497				5719021
10821.46557	94	0.03%	0.026720546				10821.47
12330.2743	92	0.03%	0.029798333				12330.27
319094.7548	77	0.84%	0.645419061				319094.8
322354.2352	70	0.85%	0.592738064			322354.2	
52622.22431	80	0.14%	0.110583565			52622.22	
1665756.293	80	4.38%	3.500522282			1665756	
87181.53654	70	0.23%	0.160307542			87181.54	
105844.5141	70	0.28%	0.194624626			105844.5	
565298.8588	70	1.48%	1.039459435			565298.9	
74.97518298	80	0.00%	0.000157557			74.97518	
325813.1896	80	0.86%	0.684683789			325813.2	
1345.517289	91	0.00%	0.003216341			1345.517	
638753.1482	70	1.68%	1.174525609			638753.1	
121843.4114	55	0.32%	0.176033829		121843.4		
271865.4751	84	0.71%	0.599880496		271865.5		
1243522.72	70	3.27%	2.286562946		1243523		
2542.654967	55	0.01%	0.003673512		2542.655		
89468.13376	84	0.24%	0.197414506		89468.13		
72342.74314	55	0.19%	0.104517511		72342.74		
41812.14219	90	0.11%	0.098849921			41812.14	
1059241.205	80	2.78%	2.225954334			1059241	
109107.691	70	0.29%	0.200624885			109107.7	
408918.1118	80	1.07%	0.859325561			408918.1	
467145.3928	91	1.23%	1.116670027			467145.4	
18350.25242	70	0.05%	0.033742051			18350.25	
274985.132	84	0.72%	0.606764126		274985.1		
211.8229852	70	0.00%	0.000389496		211.823		
172380.9532	55	0.45%	0.249048175		172381		
23449.56254	55	0.06%	0.033878863		23449.56		
3418.513249	55	0.01%	0.004938913		3418.513		
574689.0204	70	1.51%	1.056725863		574689		
190764.7412	80	0.50%	0.400884709			190764.7	

Area (sq. ft)	CN Values	Percent of Area	Weighted CN	Soil Types and Area (sq. ft)			
				A	B	C	D
175058.4882	80	0.46%	0.367878627			175058.5	
492320.6286	70	1.29%	0.905268628		492320.6		
48037.61209	55	0.13%	0.069402561		48037.61		
207730.282	70	0.55%	0.381969994		207730.3		
5189.853769	86	0.01%	0.011724247		5189.854		
832072.4508	70	2.19%	1.529997002		832072.5		
154384.0766	80	0.41%	0.324432153			154384.1	
3335.97065	80	0.01%	0.007010413			3335.971	
49707.06033	80	0.13%	0.104457461			49707.06	
415535.4133	70	1.09%	0.764077619			415535.4	
287967.4427	94	0.76%	0.711054092			287967.4	
21855.94332	90	0.06%	0.051670595			21855.94	
290024.5593	80	0.76%	0.60947537			290024.6	
116058.9682	70	0.30%	0.213406745			116059	
58247.69726	94	0.15%	0.143826202			58247.7	
331382.2199	90	0.87%	0.783435251			331382.2	
109863.6745	70	0.29%	0.202014972			109863.7	
108040.5441	70	0.28%	0.198662639		108040.5		
30431.89507	85	0.08%	0.067948413				30431.9
30431.89507	77	0.08%	0.061553269				30431.9
393577.0476	85	1.03%	0.878779842				393577
393577.0476	77	1.03%	0.796071151				393577
332540.5778	80	0.87%	0.698821134			332540.6	
332540.5778	70	0.87%	0.611468493			332540.6	
984692.9845	80	2.59%	2.069294138			984693	
984692.9845	70	2.59%	1.810632371			984693	
202.2943517	91	0.00%	0.000483567			202.2944	
202.2943517	70	0.00%	0.000371975			202.2944	
33.53667734	91	0.00%	8.01665E-05			33.53668	
33.53667734	70	0.00%	6.16665E-05			33.53668	

Summary:

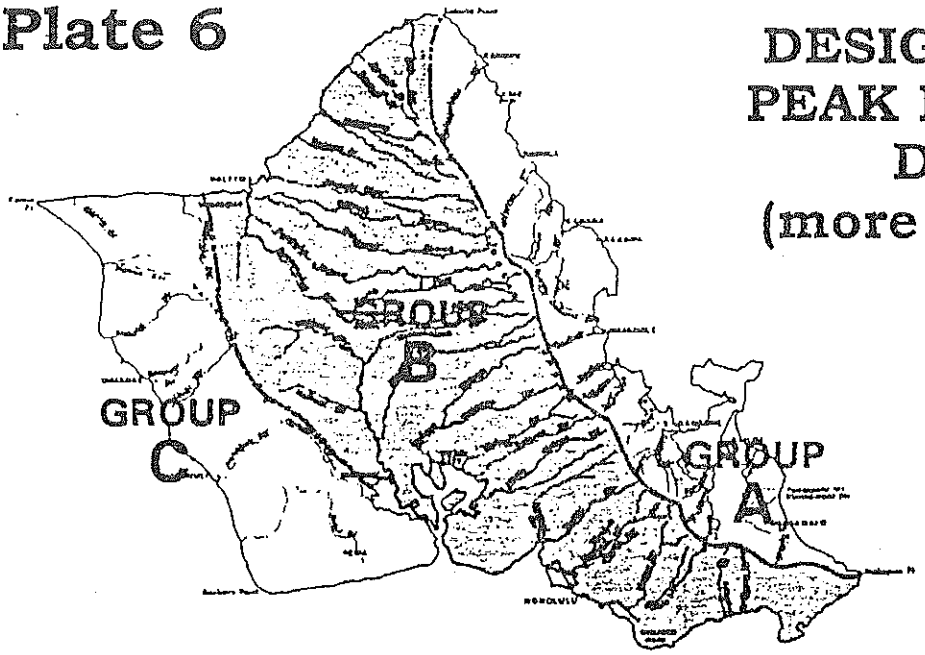
Total Area (sq. miles)	**CN:**	**76.86902931**	**Total Area for Each Type in Percent**			
1.365528467			**0.00%**	**11.94%**	**28.13%**	**59.93%**

APPENDIX 4

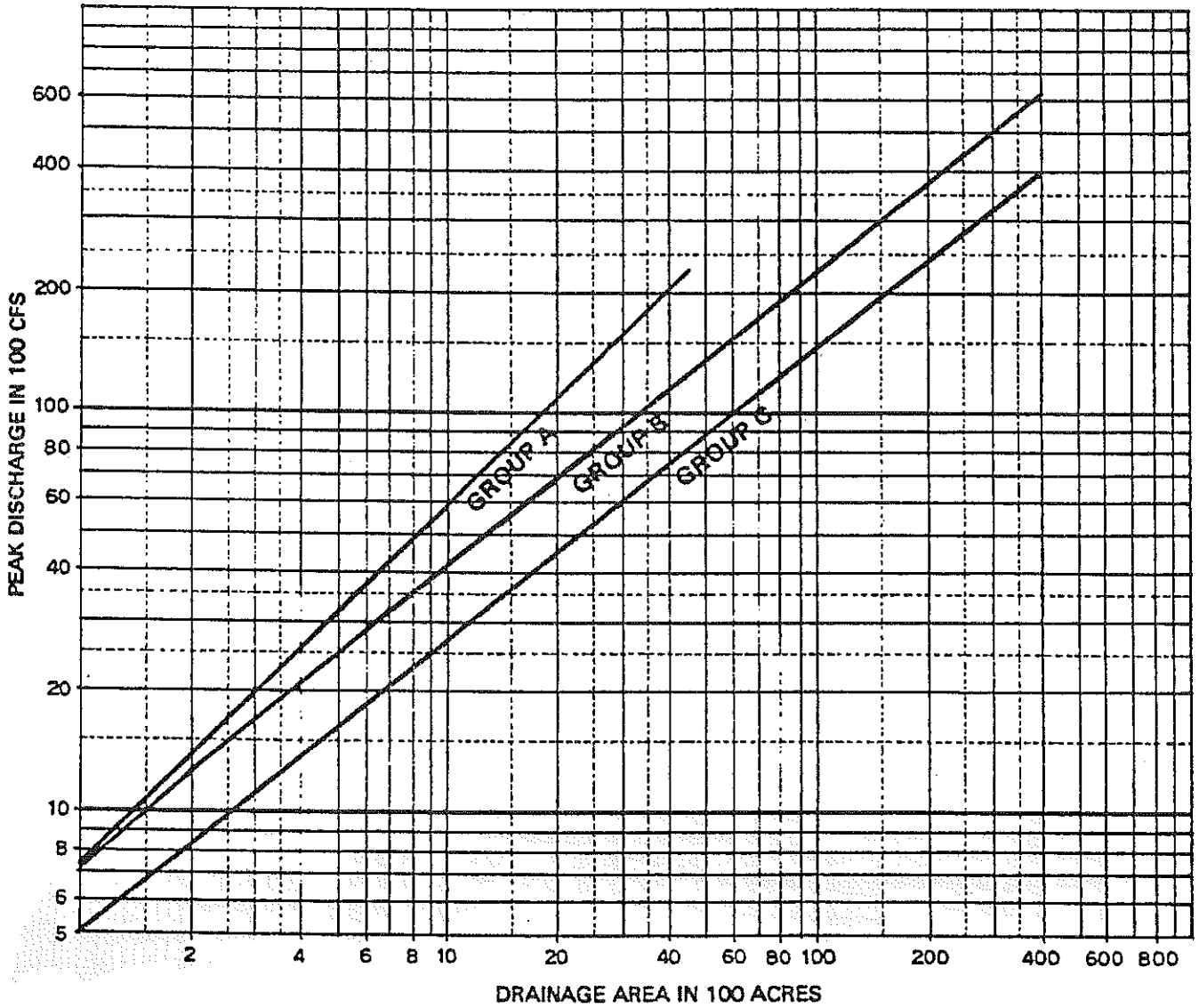
Plate 6 – Storm Drainage Standards, City and County of Honolulu

Plate 6

DESIGN CURVES FOR PEAK DISCHARGE VS. DRAINAGE AREA (more than 100 acres)



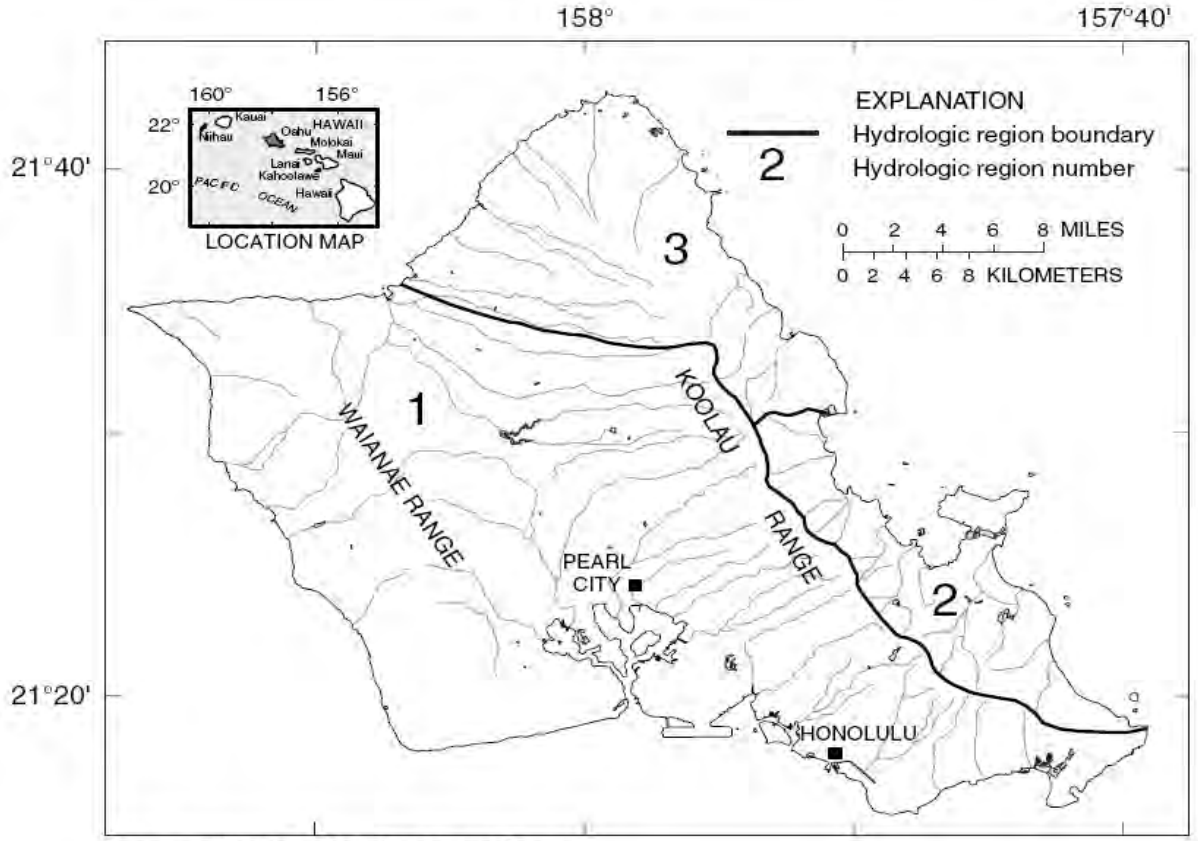
● CURVES ARE FOR STREAM CHANNELS AND DRAINAGE STRUCTURES.



SOURCE: DATA FROM U.S. GEOLOGICAL SURVEY
REV. MAY 1988

APPENDIX 5

USGS Regression Method



Base modified from U.S. Geological Survey digital data, 1:24,000, 1983, Albers equal area projection, standard parallels 21°15' and 21°45', central meridian 157°59'

Figure 1. Hydrologic regions for the Island of Oahu, Hawaii.

Table 1. Flood-peak discharge regression equations and associated statistics for streams that drain rural areas in Hawaii, island of Oahu (modified from Wong, 1994)

[Q_T, flood-peak discharge, in cubic feet per second, for recurrence interval T, 2 to 100 years; DA, drainage area, in square miles; P, median annual precipitation, in inches; P224, 2-year, 24-hour precipitation intensity, in inches]

Regression equation	Bias correction factor	Average standard error of prediction in percent	Equivalent years of record
	Region 1 (Leeward)		
$Q_2 = 3.26DA^{0.634}P^{1.08}$	1.115	43	4.2
$Q_5 = 25.8DA^{0.642}P^{0.773}$	1.069	40	5.8
$Q_{10} = 73.5DA^{0.646}P^{0.621}$	1.052	39	8.2
$Q_{25} = 217DA^{0.646}P^{0.464}$	1.040	38	11.4
$Q_{50} = 425DA^{0.645}P^{0.368}$	1.037	38	13.7
$Q_{100} = 758DA^{0.643}P^{0.286}$	1.040	39	15.8
	Region 2 (Windward)		
$Q_2 = 525DA^{0.704}$	1.165	62	2.5
$Q_5 = 1{,}140DA^{0.748}$	1.138	58	3.9
$Q_{10} = 1{,}700DA^{0.763}$	1.129	54	5.7
$Q_{25} = 2{,}580DA^{0.773}$	1.124	52	8.6
$Q_{50} = 3{,}360DA^{0.776}$	1.125	51	11.0
$Q_{100} = 4{,}250DA^{0.777}$	1.133	50	13.6
	Region 3 (North)		
$Q_2 = 0.00356DA^{0.870}P224^{5.85}$	1.036	45	3.6
$Q_5 = 0.151DA^{0.836}P224^{4.30}$	1.000	34	8.3
$Q_{10} = 1.76DA^{0.805}P224^{3.24}$	1.000	34	10.2
$Q_{25} = 24.8DA^{0.777}P224^{2.10}$	1.000	38	10.7
$Q_{50} = 125DA^{0.765}P224^{1.39}$	1.000	43	10.5
$Q_{100} = 500DA^{0.758}P224^{0.792}$	1.011	48	10.1

APPENDIX 6

NRCS WinTR-20 Model Results

Aiea Stream Project Site

STORM 100-yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		4.742		11.30	1346.99	1036.15
OUTLET	1.300		4.742		11.30	1346.99	1036.15

STORM 50-yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		3.987		11.31	1121.33	862.56
OUTLET	1.300		3.987		11.31	1121.33	862.56

STORM 25-yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		3.257		11.31	904.47	695.74
OUTLET	1.300		3.257		11.31	904.47	695.74

STORM 10-yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		2.369		11.29	639.14	491.65
OUTLET	1.300		2.369		11.29	639.14	491.65

STORM 5-yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		1.746		11.31	453.74	349.03
OUTLET	1.300		1.746		11.31	453.74	349.03

STORM 2-yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		1.022		11.34	240.59	185.07
OUTLET	1.300		1.022		11.34	240.59	185.07

STORM 100-yr-2

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		8.810		11.37	2743.04	2110.03
OUTLET	1.300		8.810		11.37	2743.04	2110.03

STORM 50-yr-2

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		7.451		11.37	2320.79	1785.22
OUTLET	1.300		7.451		11.37	2320.79	1785.22

STORM 25-yr-2

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		6.152		11.34	1915.59	1473.53
OUTLET	1.300		6.152		11.34	1915.59	1473.53

STORM 10-yr-2

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		4.534		11.35	1400.62	1077.40
OUTLET	1.300		4.534		11.35	1400.62	1077.40

STORM 5-yr-2

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		3.405		11.35	1036.32	797.17
OUTLET	1.300		3.405		11.35	1036.32	797.17

STORM 2-yr-2

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		2.043		11.36	595.19	457.84
OUTLET	1.300		2.043		11.36	595.19	457.84

STORM 100-yr-3

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		6.564		11.27	1881.29	1447.15
OUTLET	1.300		6.564		11.27	1881.29	1447.15

STORM 50-yr-3

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		5.522		11.27	1575.24	1211.73
OUTLET	1.300		5.522		11.27	1575.24	1211.73

STORM 25-yr-3

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		4.526		11.28	1280.84	985.26
OUTLET	1.300		4.526		11.28	1280.84	985.26

STORM 10-yr-3

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		3.309		11.32	919.39	707.22
OUTLET	1.300		3.309		11.32	919.39	707.22

STORM 5-yr-3

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		2.468		11.33	668.58	514.29
OUTLET	1.300		2.468		11.33	668.58	514.29

STORM 2-yr-3

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
1	1.300		1.481		11.31	374.55	288.11
OUTLET	1.300		1.481		11.31	374.55	288.11

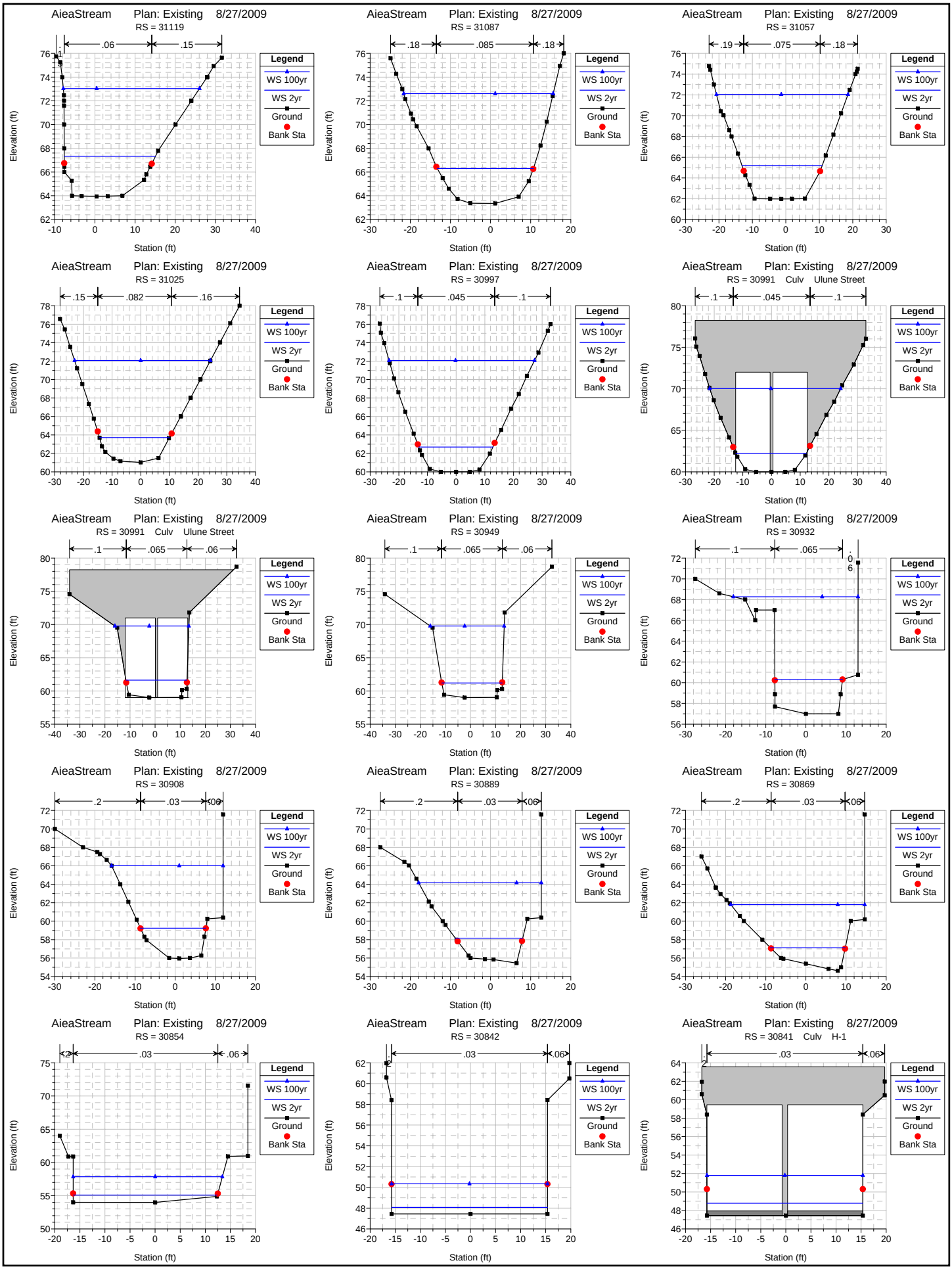
APPENDIX 7

HEC-RAS Model Geometry Setup

31119
31087
31057
31025
30991
30949
30908
30869
30842
30667
30629
30579
30551
30523
30492
30464
30444
30421
30393
30359
30319
30292
30250
30210
30178
30149
30122
30095
30068
30042
30016

APPENDIX 8

HEC-RAS Cross Sections of Existing Condition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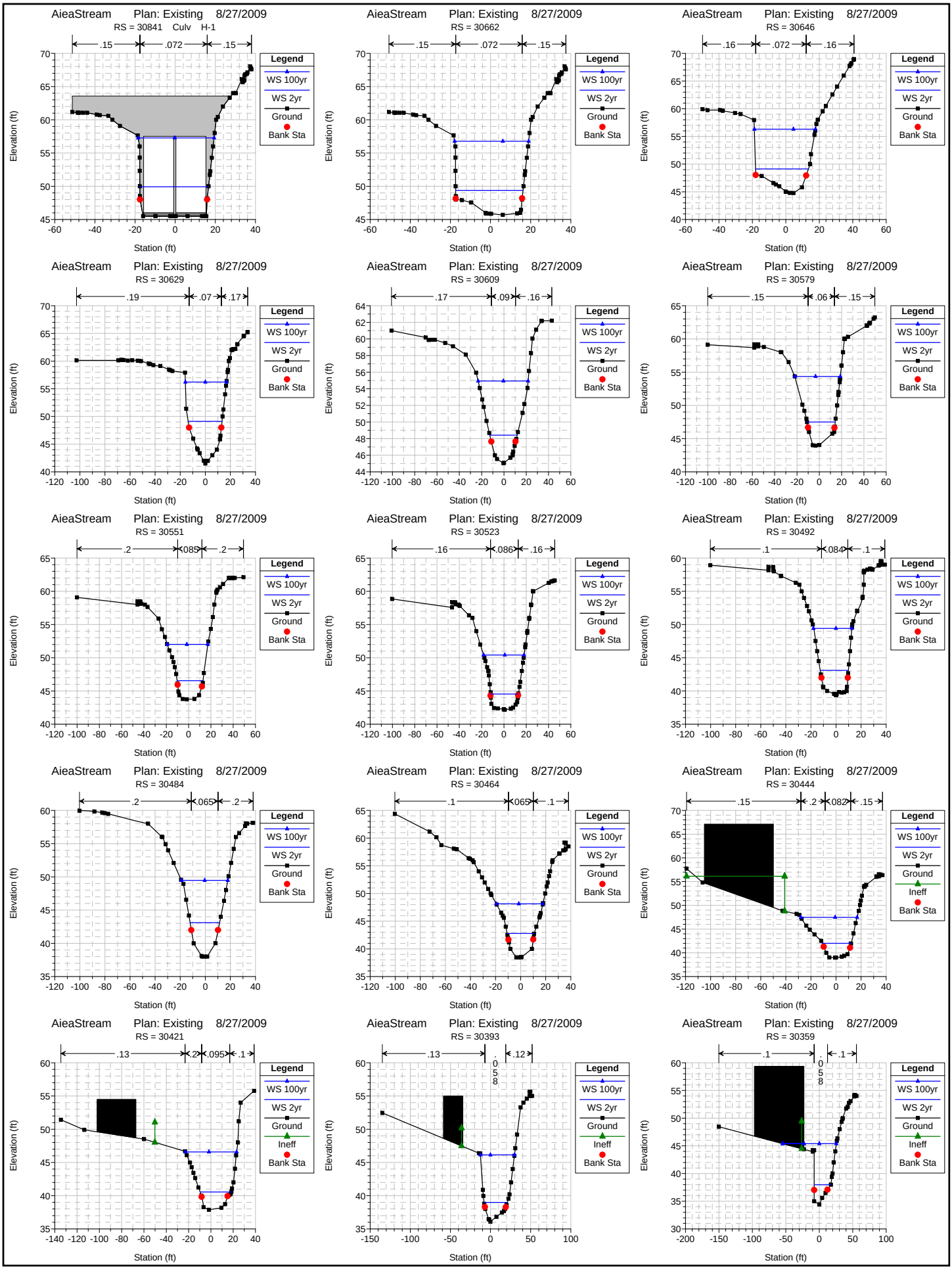
RS = 31057
.19 .075 .18
AieaStream Plan: Existing 8/27/2009
RS = 31025
.15 .082 .16
AieaStream Plan: Existing 8/27/2009
RS = 30997
.1 .045 .1
AieaStream Plan: Existing 8/27/2009
RS = 30991 Culv Ulune Street
.1 .045 .1
AieaStream Plan: Existing 8/27/2009
RS = 30991 Culv Ulune Street
.1 .065 .06
AieaStream Plan: Existing 8/27/2009
RS = 30949
.1 .065 .06
AieaStream Plan: Existing 8/27/2009
RS = 30932
.1 .065
AieaStream Plan: Existing 8/27/2009
RS = 30908
.2 .03 .06
AieaStream Plan: Existing 8/27/2009
RS = 30889
.2 .03 .06
AieaStream Plan: Existing 8/27/2009
RS = 30869
.2 .03 .06
AieaStream Plan: Existing 8/27/2009
RS = 30854
.2 .03 .06
AieaStream Plan: Existing 8/27/2009
RS = 30842
.03 .06
AieaStream Plan: Existing 8/27/2009
RS = 30841 Culv H-1
.03 .06
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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AieaStream Plan: Existing 8/27/2009
RS = 30662
.15 .072 .15
AieaStream Plan: Existing 8/27/2009
RS = 30646
.16 .072 .16
AieaStream Plan: Existing 8/27/2009
RS = 30629
.19 .07 .17
AieaStream Plan: Existing 8/27/2009
RS = 30609
.17 .09 .16
AieaStream Plan: Existing 8/27/2009
RS = 30579
.15 .06 .15
AieaStream Plan: Existing 8/27/2009
RS = 30551
.2 .085 .2
AieaStream Plan: Existing 8/27/2009
RS = 30523
.16 .086 .16
AieaStream Plan: Existing 8/27/2009
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AieaStream Plan: Existing 8/27/2009
RS = 30484
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AieaStream Plan: Existing 8/27/2009
RS = 30464
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AieaStream Plan: Existing 8/27/2009
RS = 30444
.15 .2 .082 .15
AieaStream Plan: Existing 8/27/2009
RS = 30421
.13 .2 .095 .1
AieaStream Plan: Existing 8/27/2009
RS = 30393
.13 .058 .12
AieaStream Plan: Existing 8/27/2009
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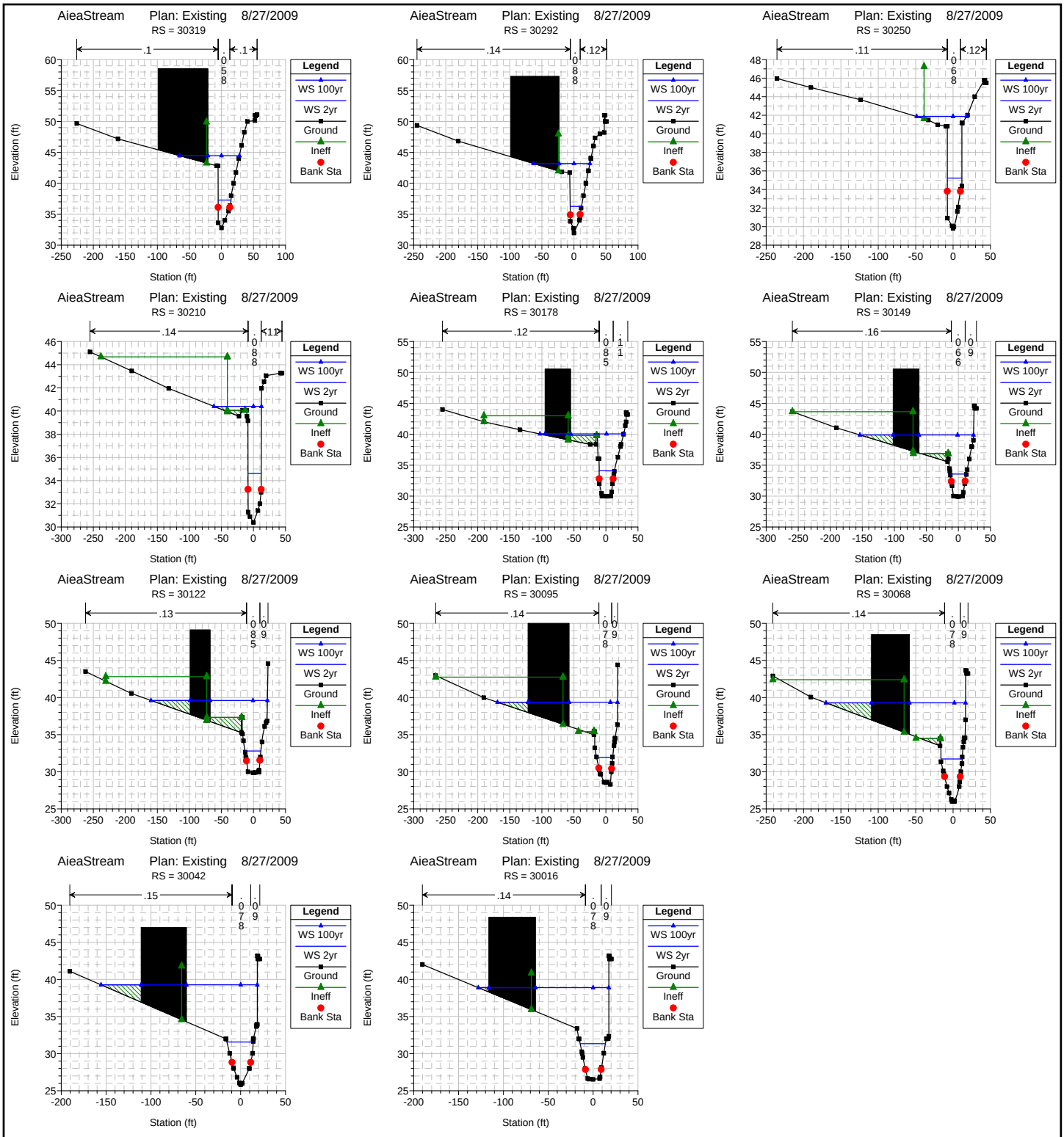
WS 100yr
WS 2yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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AieaStream Plan: Existing 8/27/2009
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AieaStream Plan: Existing 8/27/2009
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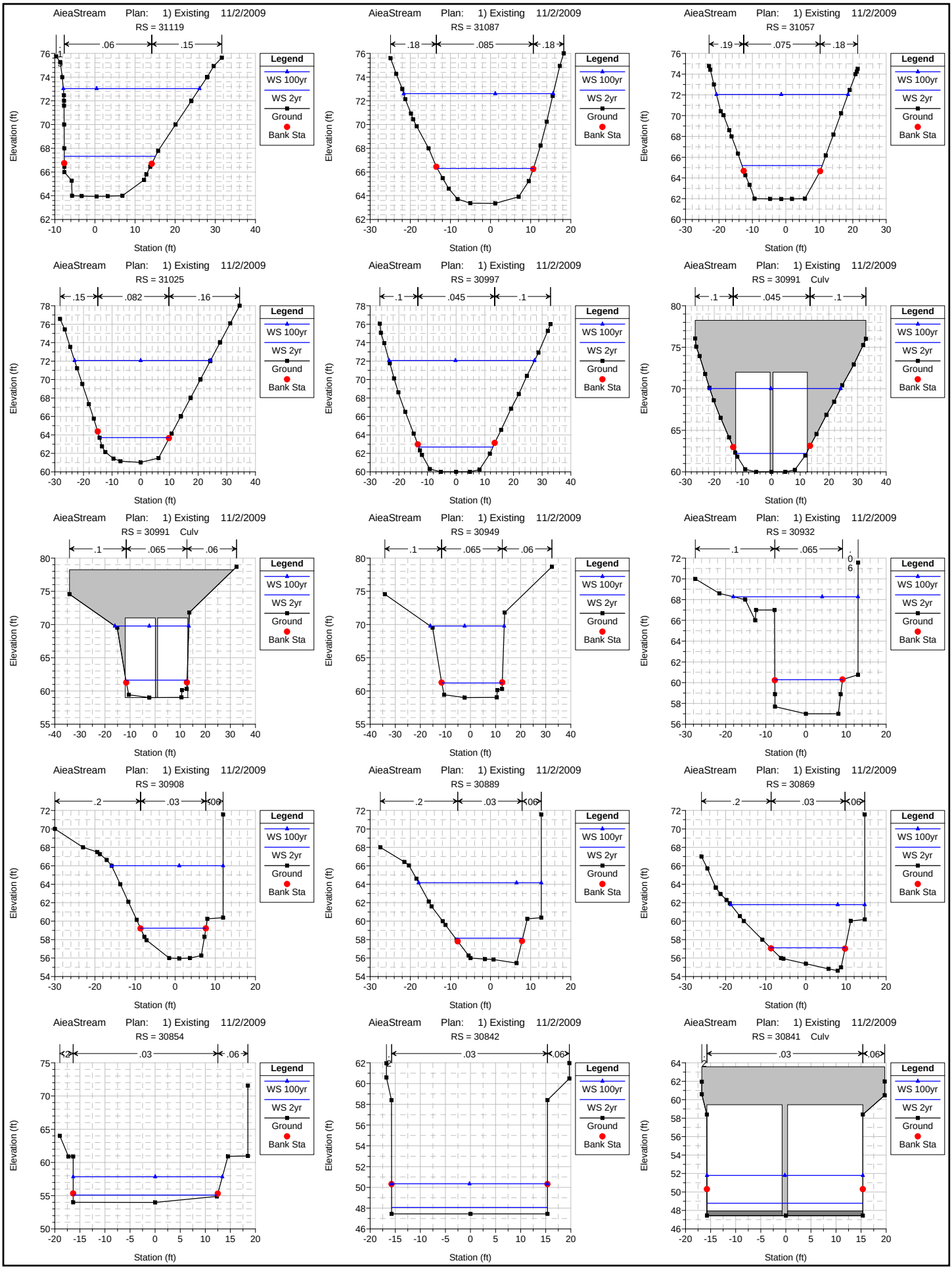
AieaStream Plan: Existing 8/27/2009
RS = 30210
AieaStream Plan: Existing 8/27/2009
RS = 30178
AieaStream Plan: Existing 8/27/2009
RS = 30149
AieaStream Plan: Existing 8/27/2009
RS = 30122
AieaStream Plan: Existing 8/27/2009
RS = 30095
AieaStream Plan: Existing 8/27/2009
RS = 30068
AieaStream Plan: Existing 8/27/2009
RS = 30042
AieaStream Plan: Existing 8/27/2009
RS = 30016
Legend
WS 100yr
WS 2yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

APPENDIX 9

HEC-RAS Cross Sections of Proposed Condition n=0.03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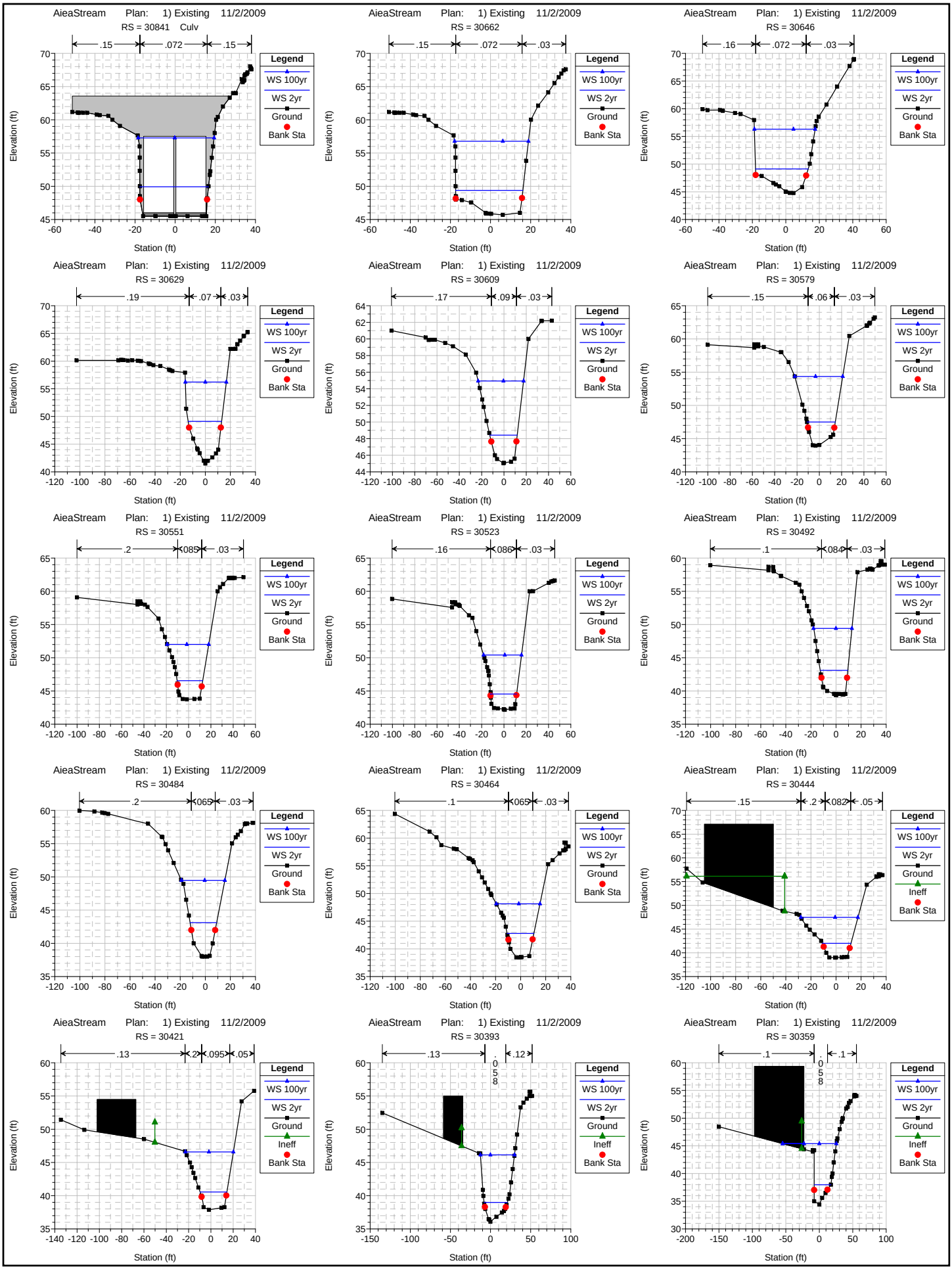
.15
AieaStream Plan: 1) Existing 11/2/2009
RS = 31087
.18
.085
.18
AieaStream Plan: 1) Existing 11/2/2009
RS = 31057
.19
.075
.18
AieaStream Plan: 1) Existing 11/2/2009
RS = 31025
.15
.082
.16
AieaStream Plan: 1) Existing 11/2/2009
RS = 30997
.1
.045
.1
AieaStream Plan: 1) Existing 11/2/2009
RS = 30991 Culv
.1
.045
.1
AieaStream Plan: 1) Existing 11/2/2009
RS = 30991 Culv
.1
.065
.06
AieaStream Plan: 1) Existing 11/2/2009
RS = 30949
.1
.065
.06
AieaStream Plan: 1) Existing 11/2/2009
RS = 30932
.1
.065
AieaStream Plan: 1) Existing 11/2/2009
RS = 30908
.2
.03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30889
.2
.03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30869
.2
.03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30854
.03
.06
AieaStream Plan: 1) Existing 11/2/2009
RS = 30842
.03
.06
AieaStream Plan: 1) Existing 11/2/2009
RS = 30841 Culv
.03
.06
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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AieaStream Plan: 1) Existing 11/2/2009
RS = 30662
.15 .072 .03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30646
.16 .072 .03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30629
.19 .07 .03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30609
.17 .09 .03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30579
.15 .06 .03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30551
.2 .085 .03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30523
.16 .086 .03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30492
.1 .084 .03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30484
.2 .065 .03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30464
.1 .065 .03
AieaStream Plan: 1) Existing 11/2/2009
RS = 30444
.15 .2 .082 .05
AieaStream Plan: 1) Existing 11/2/2009
RS = 30421
.13 .2 .095 .05
AieaStream Plan: 1) Existing 11/2/2009
RS = 30393
.13 .058 .12
AieaStream Plan: 1) Existing 11/2/2009
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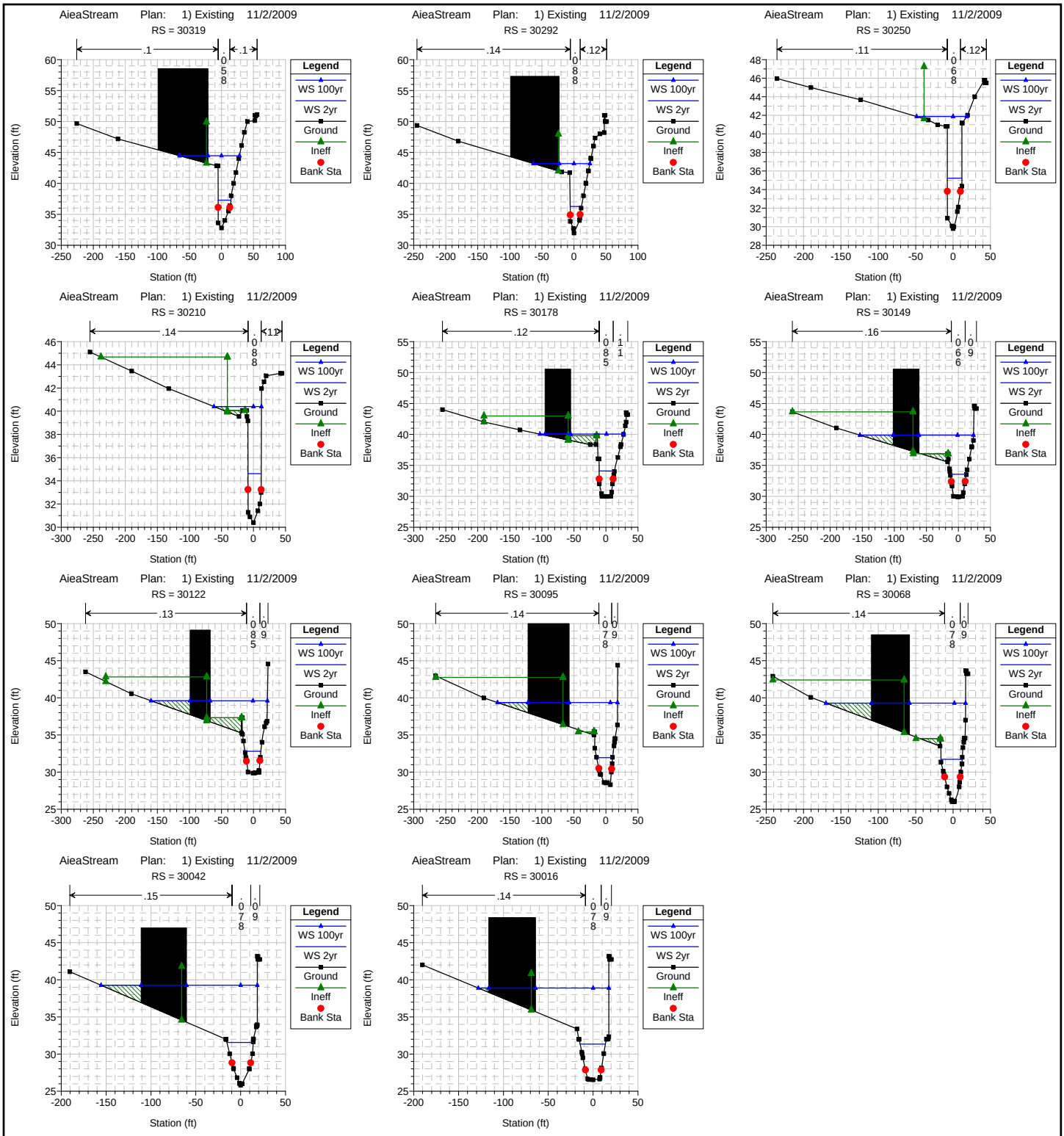
.1 .058 .1
Legend
WS 100yr
WS 2yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: 1) Existing 11/2/2009
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AieaStream Plan: 1) Existing 11/2/2009
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AieaStream Plan: 1) Existing 11/2/2009
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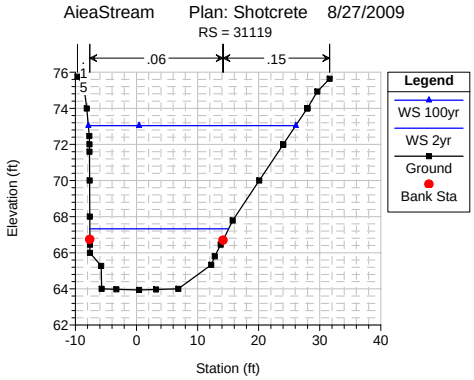
AieaStream Plan: 1) Existing 11/2/2009
RS = 30210
AieaStream Plan: 1) Existing 11/2/2009
RS = 30178
AieaStream Plan: 1) Existing 11/2/2009
RS = 30149
AieaStream Plan: 1) Existing 11/2/2009
RS = 30122
AieaStream Plan: 1) Existing 11/2/2009
RS = 30095
AieaStream Plan: 1) Existing 11/2/2009
RS = 30068
AieaStream Plan: 1) Existing 11/2/2009
RS = 30042
AieaStream Plan: 1) Existing 11/2/2009
RS = 30016
Legend
WS 100yr
WS 2yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

APPENDIX 10

HEC-RAS Cross Sections of Proposed Condition n=0.05


AieaStream Plan: Shotcrete 8/27/2009
RS = 31119
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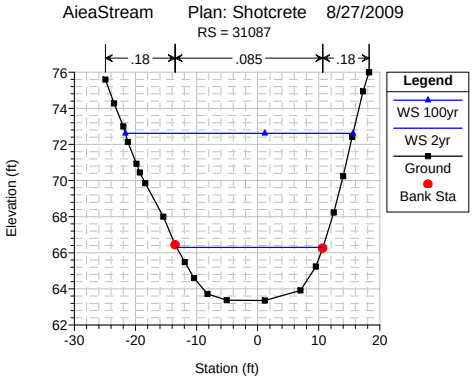
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
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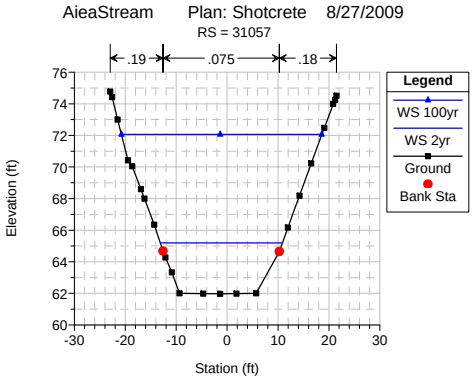
.085
.18
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
RS = 31057
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.075
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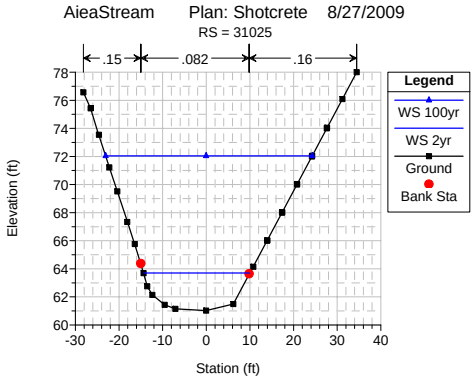
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
RS = 31025
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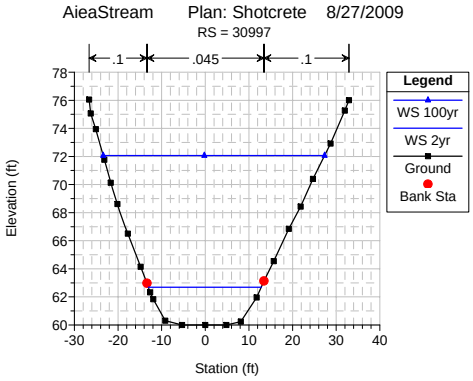
.082
.16
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
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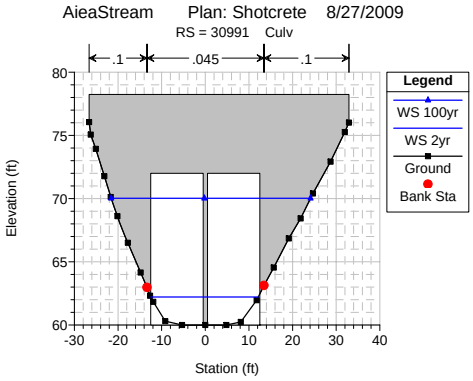
.045
.1
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
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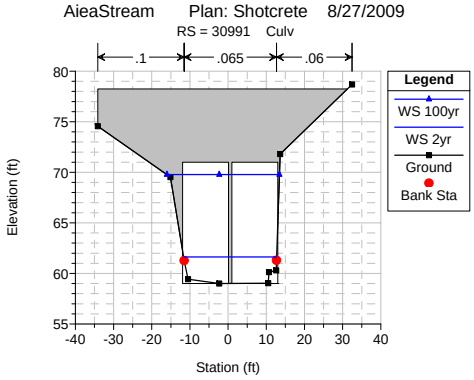
.1
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
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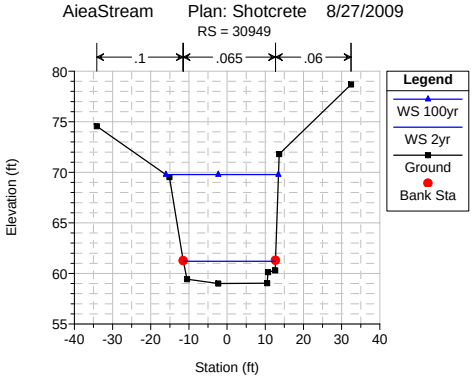
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
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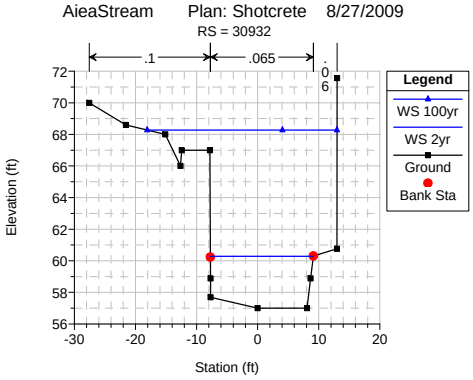
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
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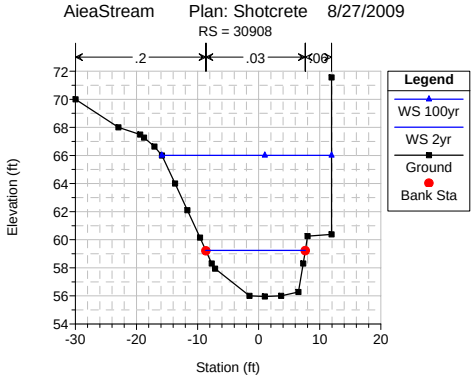
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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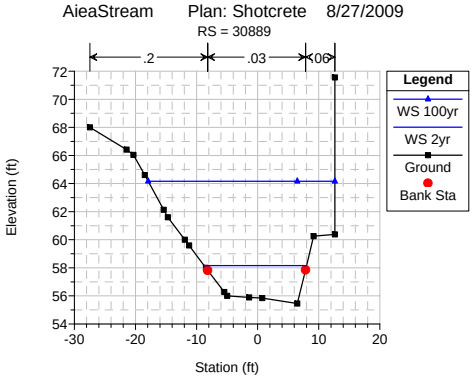
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
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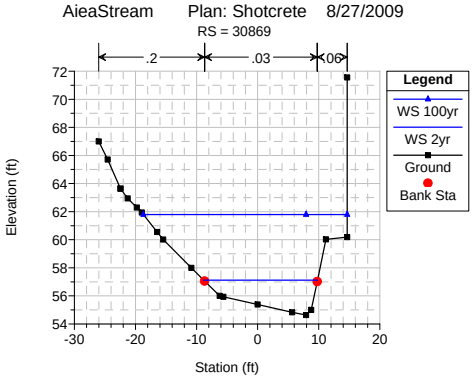
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
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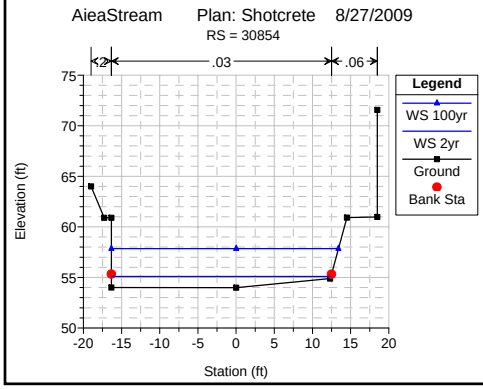
.03
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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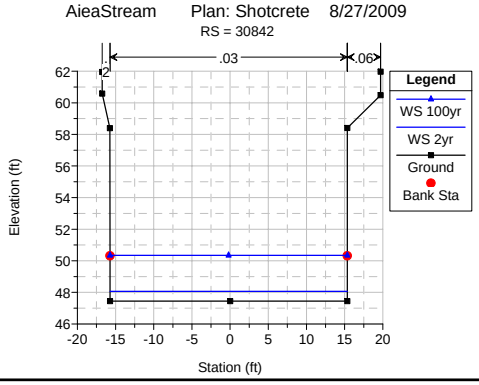
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
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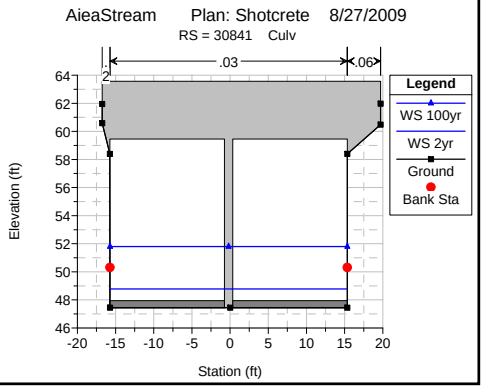
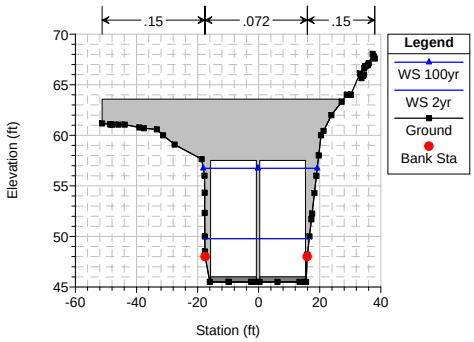
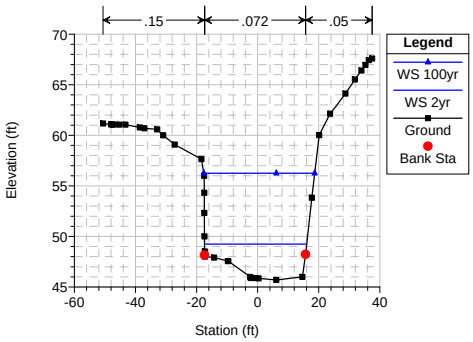
.06
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


AieaStream Plan: Shotcrete 8/27/2009
RS = 30841 Culv
.03
.06
Legend
WS 100yr
WS 2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

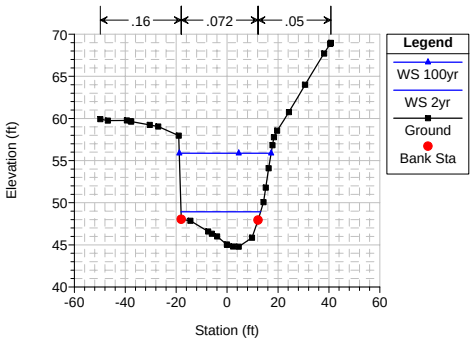
AieaStream Plan: Shotcrete 8/27/2009
RS = 30841 Culv



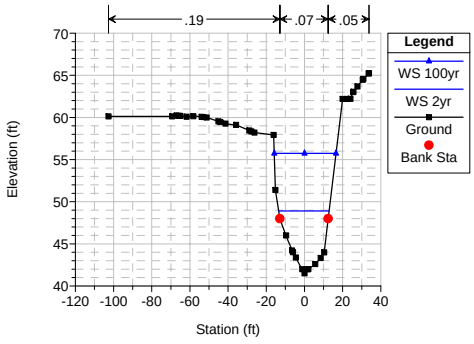
AieaStream Plan: Shotcrete 8/27/2009
RS = 30662



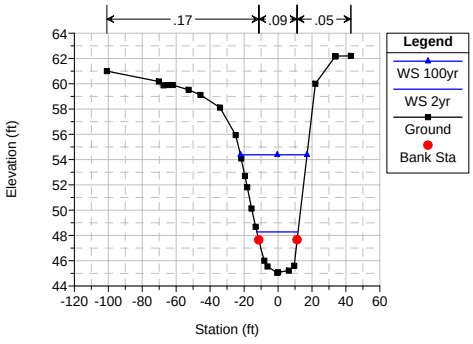
AieaStream Plan: Shotcrete 8/27/2009
RS = 30646



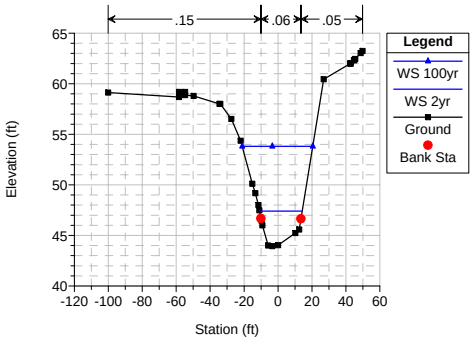
AieaStream Plan: Shotcrete 8/27/2009
RS = 30629



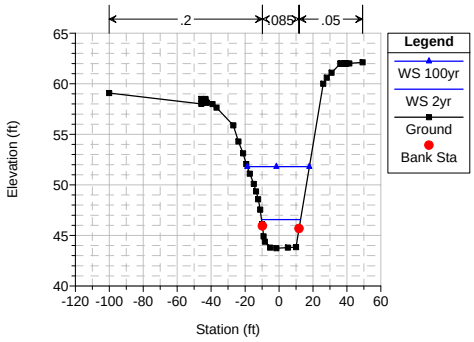
AieaStream Plan: Shotcrete 8/27/2009
RS = 30609



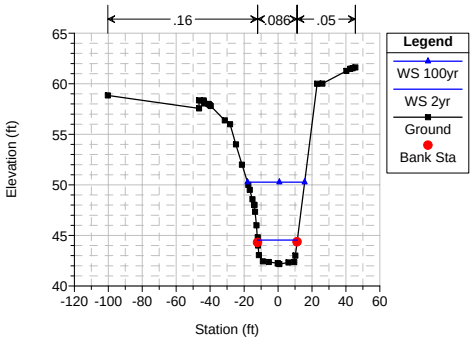
AieaStream Plan: Shotcrete 8/27/2009
RS = 30579



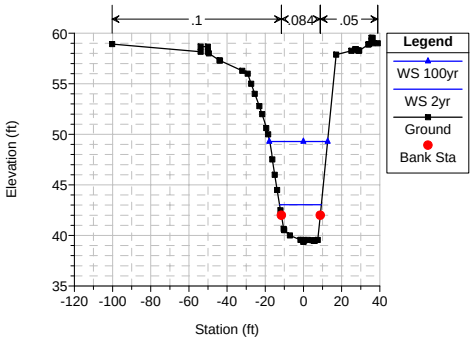
AieaStream Plan: Shotcrete 8/27/2009
RS = 30551



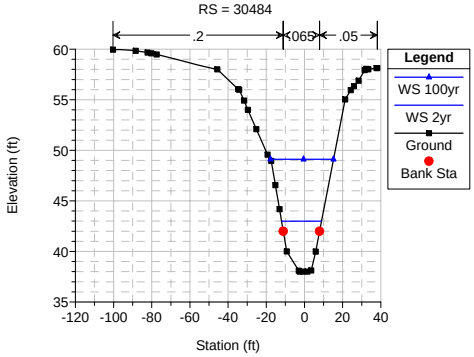
AieaStream Plan: Shotcrete 8/27/2009
RS = 30523



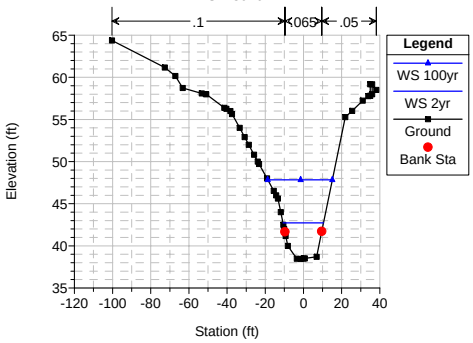
AieaStream Plan: Shotcrete 8/27/2009
RS = 30492



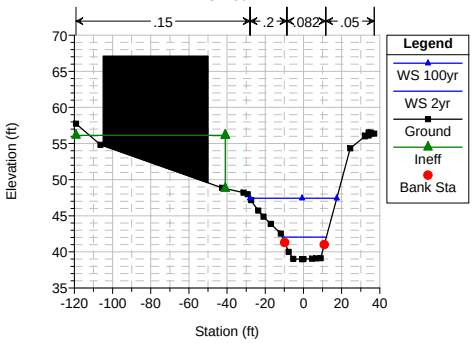
AieaStream Plan: Shotcrete 8/27/2009
RS = 30484



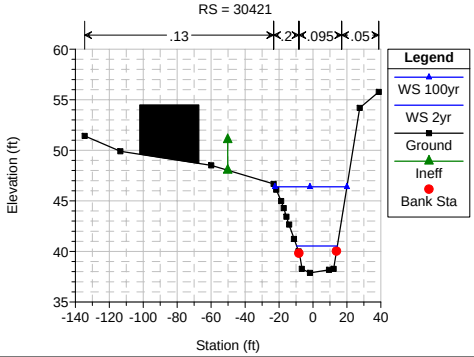
AieaStream Plan: Shotcrete 8/27/2009
RS = 30464



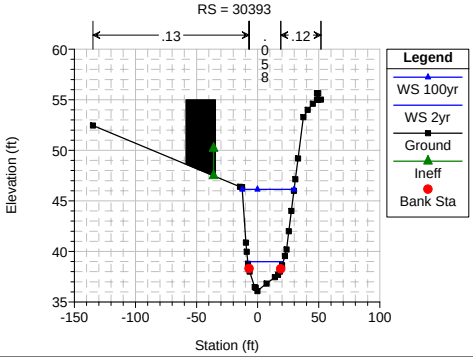
AieaStream Plan: Shotcrete 8/27/2009
RS = 30444



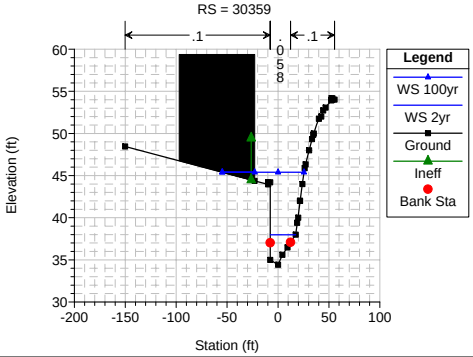
AieaStream Plan: Shotcrete 8/27/2009
RS = 30421



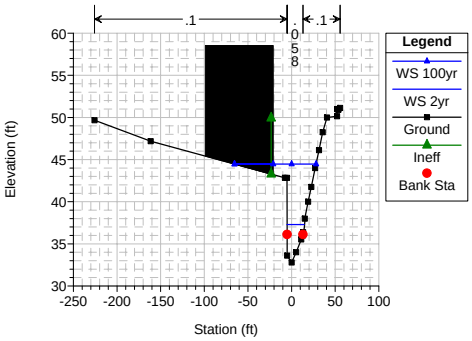
AieaStream Plan: Shotcrete 8/27/2009
RS = 30393



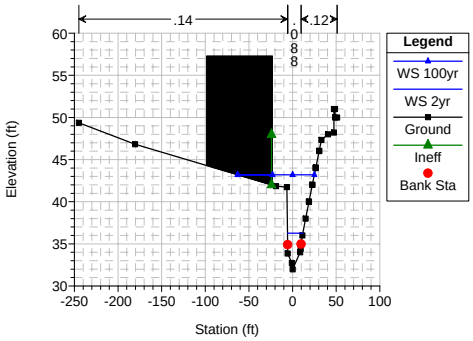
AieaStream Plan: Shotcrete 8/27/2009
RS = 30359



AieaStream Plan: Shotcrete 8/27/2009
RS = 30319



AieaStream Plan: Shotcrete 8/27/2009
RS = 30292



AieaStream Plan: Shotcrete 8/27/2009
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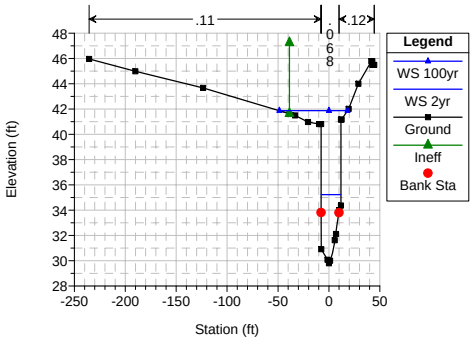
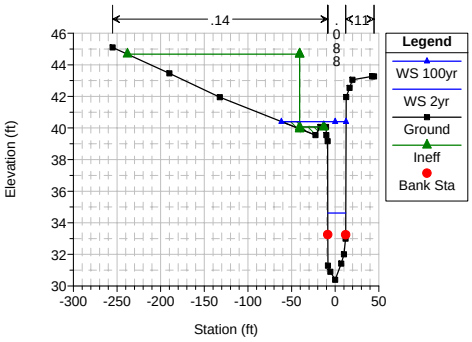


AieaStream Plan: Shotcrete 8/27/2009
RS = 30210



AieaStream Plan: Shotcrete 8/27/2009
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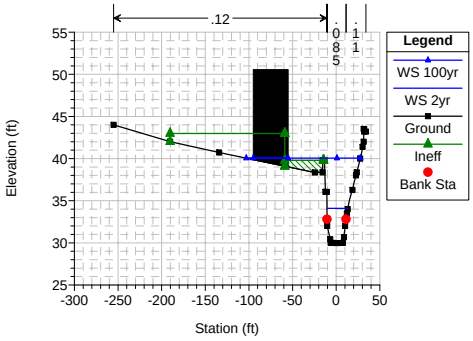
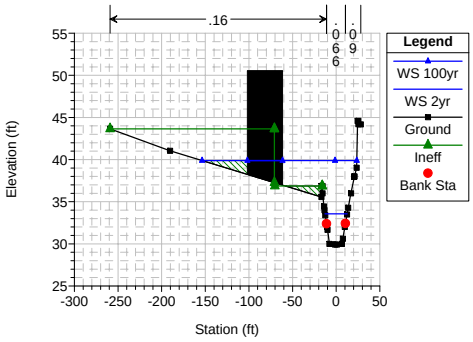
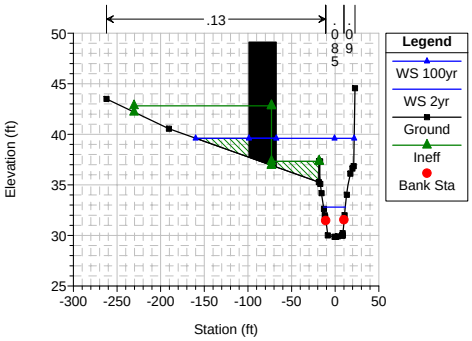


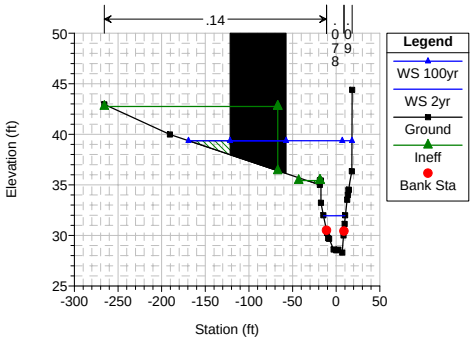
AieaStream Plan: Shotcrete 8/27/2009
RS = 30149



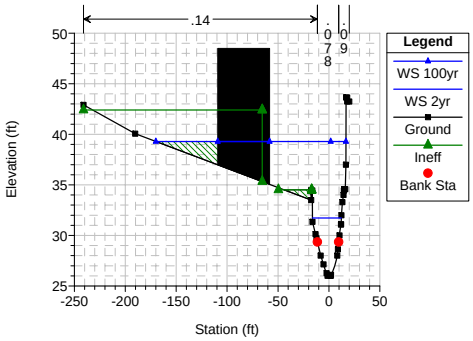
AieaStream Plan: Shotcrete 8/27/2009
RS = 30122



AieaStream Plan: Shotcrete 8/27/2009
RS = 30095



AieaStream Plan: Shotcrete 8/27/2009
RS = 30068



AieaStream Plan: Shotcrete 8/27/2009
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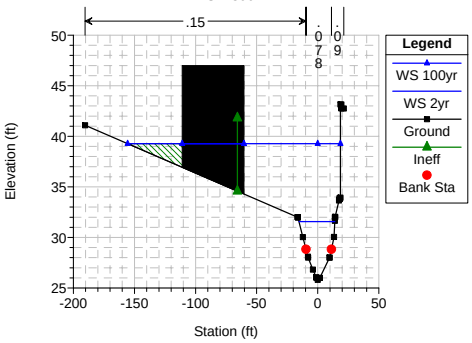
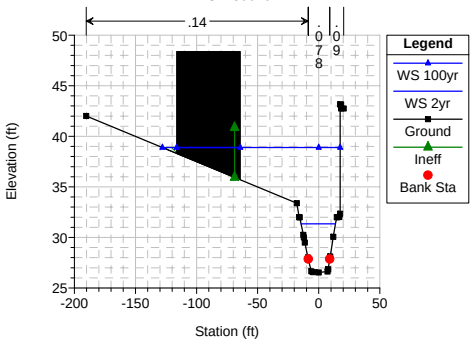


AieaStream Plan: Shotcrete 8/27/2009
RS = 30016



APPENDIX 11

HEC-RAS Friction Coefficient Table

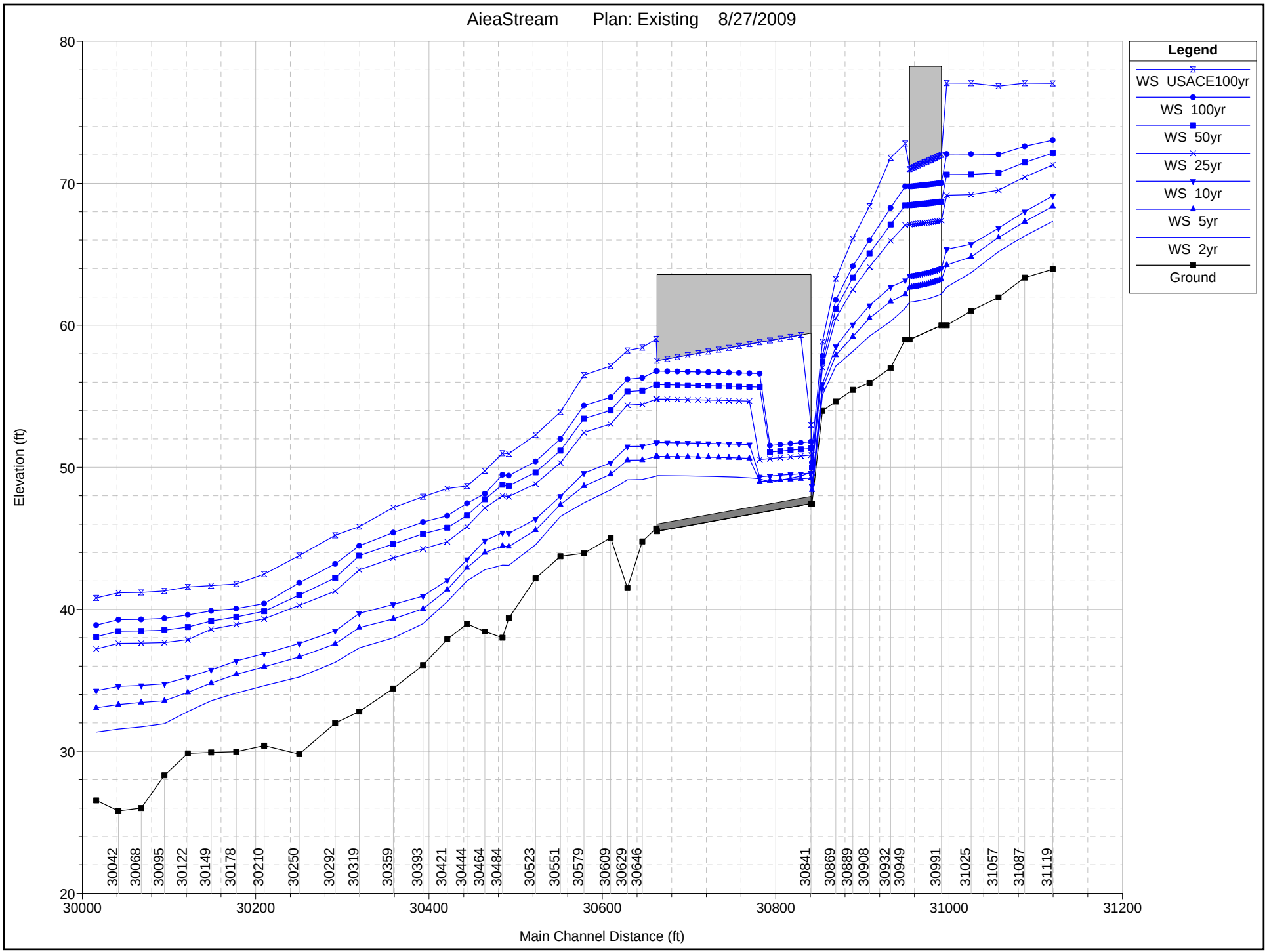
Manning's n Values

Reach	River Station	Existing			Shotcrete Wall n=0.03			Shotcrete Wall n=0.05		
		LOB	CHL	ROB	LOB	CHL	ROB	LOB	CHL	ROB
Aiea Stream	311+19	0.15	0.06	0.15	0.15	0.06	0.15	0.15	0.06	0.15
Aiea Stream	310+87	0.18	0.085	0.18	0.18	0.085	0.18	0.18	0.085	0.18
Aiea Stream	310+57	0.19	0.075	0.18	0.19	0.075	0.18	0.19	0.075	0.18
Aiea Stream	310+25	0.15	0.082	0.16	0.15	0.082	0.16	0.15	0.082	0.16
Aiea Stream	309+97	0.1	0.045	0.1	0.1	0.045	0.1	0.1	0.045	0.1
Aiea Stream	309+91	Culvert								
Aiea Stream	309+49	0.1	0.065	0.06	0.1	0.065	0.06	0.1	0.065	0.06
Aiea Stream	309+32	0.1	0.065	0.06	0.1	0.065	0.06	0.1	0.065	0.06
Aiea Stream	309+08	0.2	0.03	0.06	0.2	0.03	0.06	0.2	0.03	0.06
Aiea Stream	308+89	0.2	0.03	0.06	0.2	0.03	0.06	0.2	0.03	0.06
Aiea Stream	308+69	0.2	0.03	0.06	0.2	0.03	0.06	0.2	0.03	0.06
Aiea Stream	308+54	0.2	0.03	0.06	0.2	0.03	0.06	0.2	0.03	0.06
Aiea Stream	308+42	0.2	0.03	0.06	0.2	0.03	0.06	0.2	0.03	0.06
Aiea Stream	308+41	Culvert								
Aiea Stream	306+62	0.15	0.072	0.15	0.15	0.072	0.03	0.15	0.072	0.05
Aiea Stream	306+46	0.16	0.072	0.16	0.16	0.072	0.03	0.16	0.072	0.05
Aiea Stream	306+29	0.19	0.07	0.17	0.19	0.07	0.03	0.19	0.07	0.05
Aiea Stream	306+09	0.17	0.09	0.16	0.17	0.09	0.03	0.17	0.09	0.05
Aiea Stream	305+79	0.15	0.06	0.15	0.15	0.06	0.03	0.15	0.06	0.05
Aiea Stream	305+51	0.2	0.085	0.2	0.2	0.085	0.03	0.2	0.085	0.05
Aiea Stream	305+23	0.16	0.086	0.16	0.16	0.086	0.03	0.16	0.086	0.05
Aiea Stream	304+92	0.1	0.084	0.1	0.1	0.084	0.03	0.1	0.084	0.05
Aiea Stream	304+84	0.2	0.065	0.2	0.2	0.065	0.03	0.2	0.065	0.05
Aiea Stream	304+64	0.1	0.065	0.1	0.1	0.065	0.03	0.1	0.065	0.05
Aiea Stream	304+44	0.15	0.2	0.082	0.15	0.2	0.082	0.15	0.2	0.082
Aiea Stream	304+21	0.13	0.2	0.095	0.13	0.2	0.095	0.13	0.2	0.095
Aiea Stream	303+93	0.13	0.058	0.12	0.13	0.058	0.12	0.13	0.058	0.12
Aiea Stream	303+59	0.1	0.058	0.1	0.1	0.058	0.1	0.1	0.058	0.1
Aiea Stream	303+19	0.1	0.058	0.1	0.1	0.058	0.1	0.1	0.058	0.1
Aiea Stream	302+92	0.14	0.088	0.12	0.14	0.088	0.12	0.14	0.088	0.12
Aiea Stream	302+50	0.11	0.068	0.12	0.11	0.068	0.12	0.11	0.068	0.12
Aiea Stream	302+10	0.14	0.088	0.11	0.14	0.088	0.11	0.14	0.088	0.11
Aiea Stream	301+78	0.12	0.085	0.11	0.12	0.085	0.11	0.12	0.085	0.11

Reach	River Station	Existing			Shotcrete Wall n=0.03			Shotcrete Wall n=0.05		
		LOB	CHL	ROB	LOB	CHL	ROB	LOB	CHL	ROB
Aiea Stream	301+49	0.16	0.066	0.09	0.16	0.066	0.09	0.16	0.066	0.09
Aiea Stream	301+22	0.13	0.085	0.09	0.13	0.085	0.09	0.13	0.085	0.09
Aiea Stream	300+95	0.14	0.078	0.09	0.14	0.078	0.09	0.14	0.078	0.09
Aiea Stream	300+68	0.14	0.078	0.09	0.14	0.078	0.09	0.14	0.078	0.09
Aiea Stream	300+42	0.15	0.078	0.09	0.15	0.078	0.09	0.15	0.078	0.09
Aiea Stream	300+16	0.14	0.078	0.09	0.14	0.078	0.09	0.14	0.078	0.09

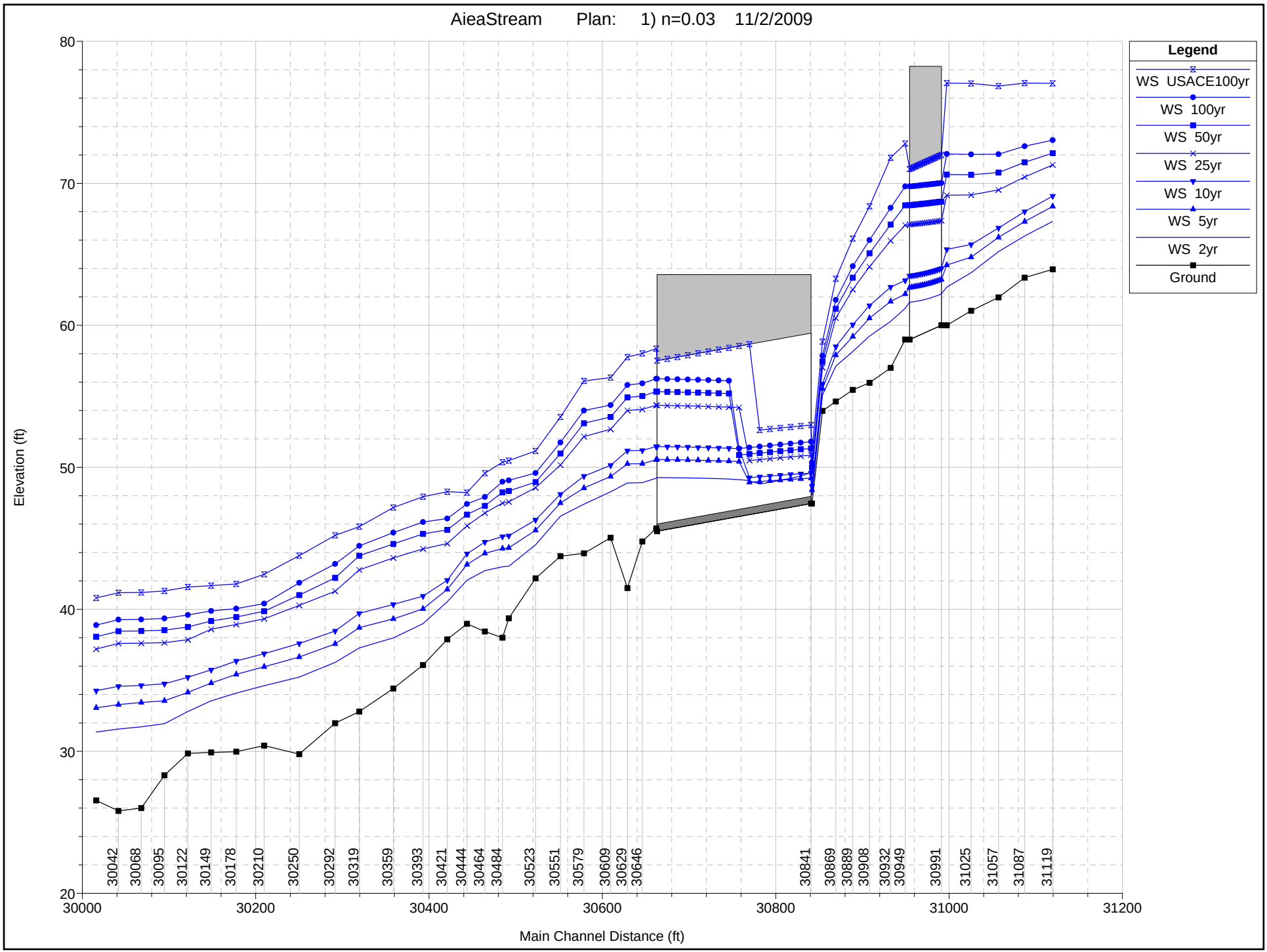
APPENDIX 12

HEC-RAS Water Surface Profile Results for Existing Condition


AieaStream Plan: Existing 8/27/2009
Legend
WS USACE100yr
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 5yr
WS 2yr
Ground
Elevation (ft)
Main Channel Distance (ft)
80
70
60
50
40
30
20
30000
30200
30400
30600
30800
31000
31200
30042
30068
30095
30122
30149
30178
30210
30250
30292
30319
30359
30393
30421
30444
30464
30484
30523
30551
30579
30609
30629
30646
30841
30869
30889
30908
30932
30949
30991
31025
31057
31087
31119

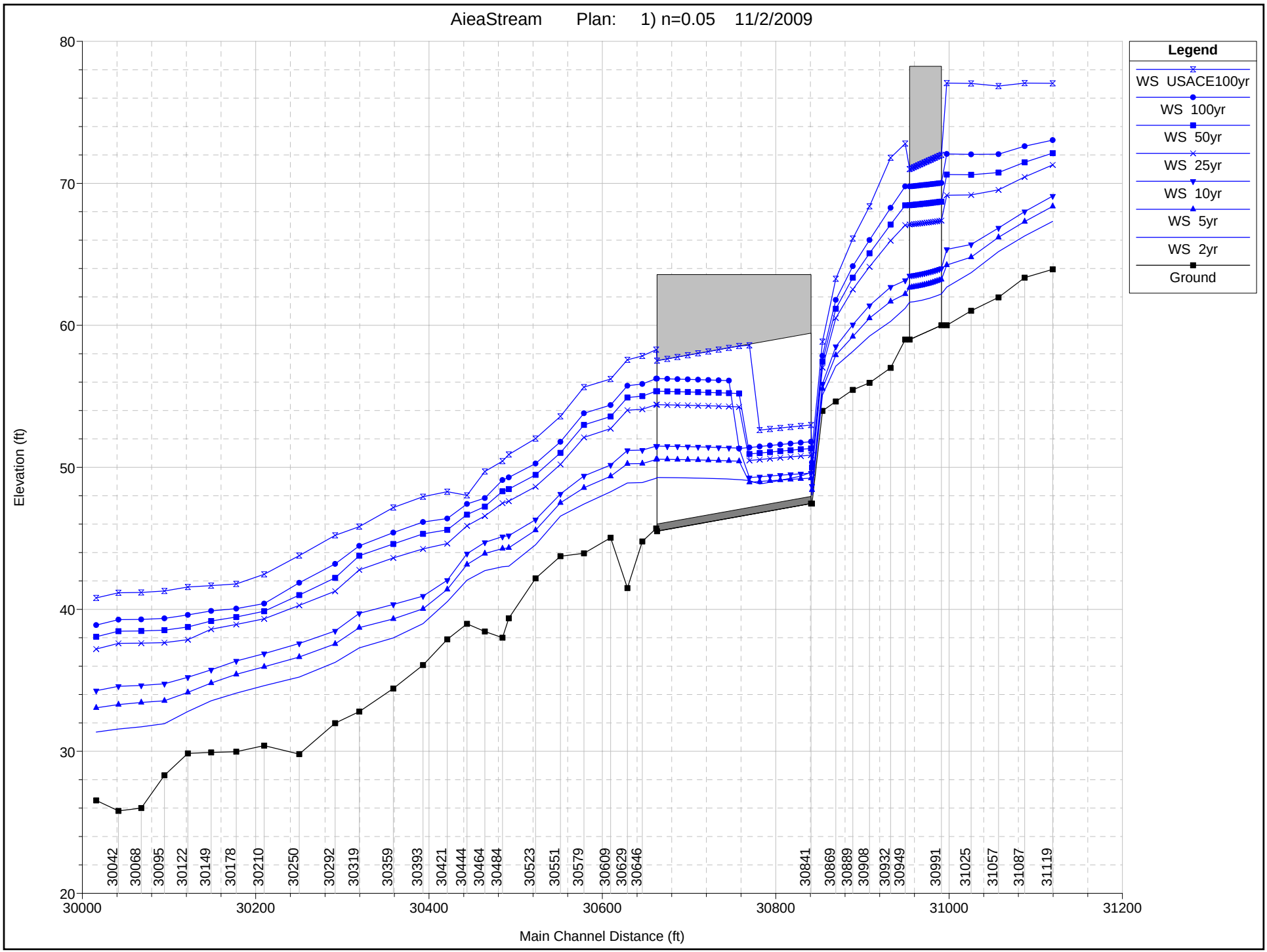
APPENDIX 13

HEC-RAS Water Surface Profile Results for Proposed Condition n=0.03


AieaStream Plan: 1) n=0.03 11/2/2009
Legend
WS USACE100yr
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 5yr
WS 2yr
Ground
Elevation (ft)
Main Channel Distance (ft)
80
70
60
50
40
30
20
30000
30200
30400
30600
30800
31000
31200
30042
30068
30095
30122
30149
30178
30210
30250
30292
30319
30359
30393
30421
30444
30464
30484
30523
30551
30579
30609
30629
30646
30841
30869
30889
30908
30932
30949
30991
31025
31057
31087
31119

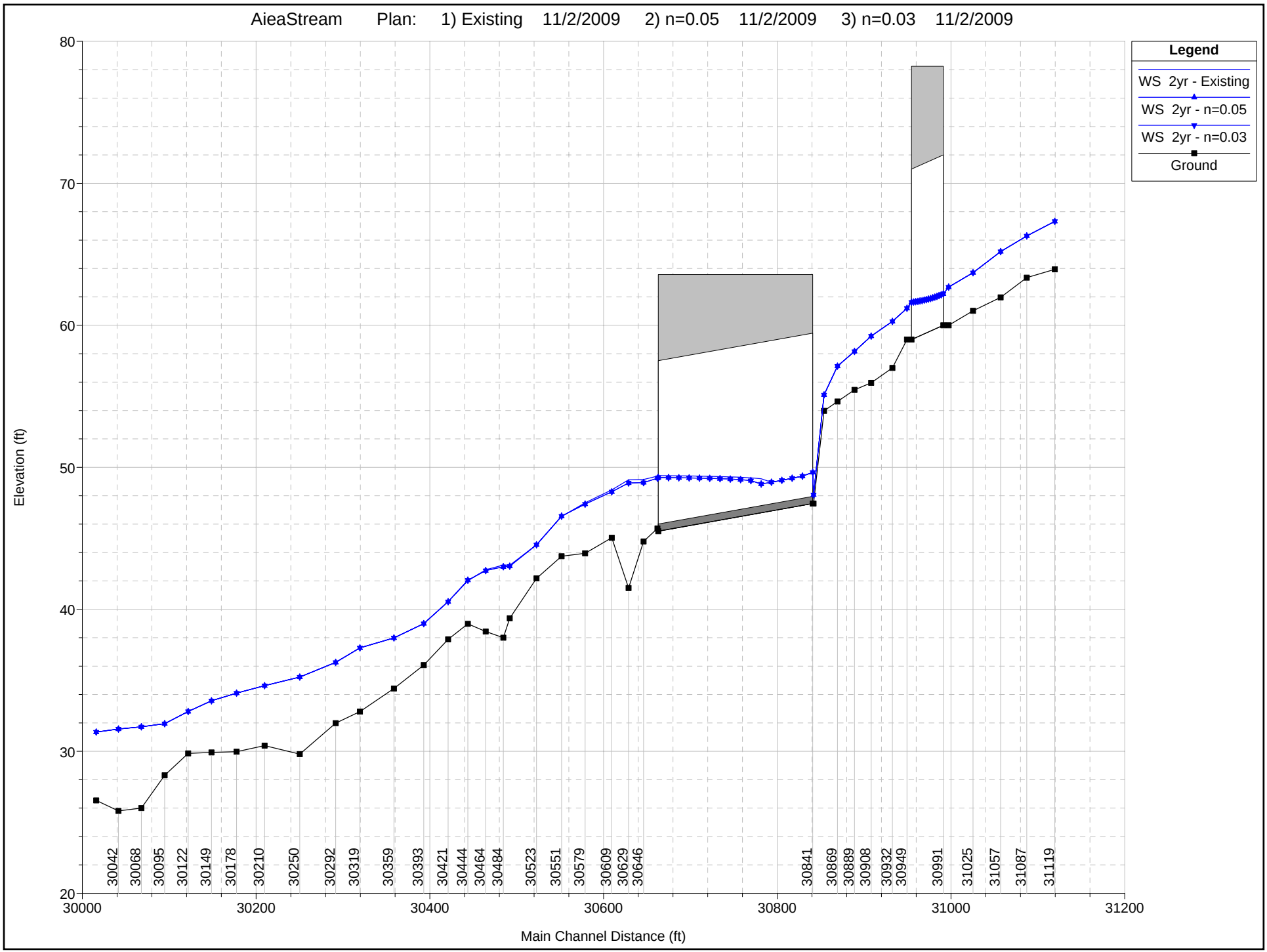
APPENDIX 14

HEC-RAS Water Surface Profile Results for Proposed Condition n=0.05


AieaStream Plan: 1) n=0.05 11/2/2009
Legend
WS USACE100yr
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 5yr
WS 2yr
Ground
Elevation (ft)
Main Channel Distance (ft)
80
70
60
50
40
30
20
30000
30200
30400
30600
30800
31000
31200
30042
30068
30095
30122
30149
30178
30210
30250
30292
30319
30359
30393
30421
30444
30464
30484
30523
30551
30579
30609
30629
30646
30841
30869
30889
30908
30932
30949
30991
31025
31057
31087
31119

APPENDIX 15

HEC-RAS Water Surface Profile Results Comparisons Figures


AieaStream Plan: 1) Existing 11/2/2009 2) n=0.05 11/2/2009 3) n=0.03 11/2/2009
Legend
WS 2yr - Existing
WS 2yr - n=0.05
WS 2yr - n=0.03
Ground
Elevation (ft)
Main Channel Distance (ft)
80
70
60
50
40
30
20
30000
30200
30400
30600
30800
31000
31200
30042
30068
30095
30122
30149
30178
30210
30250
30292
30319
30359
30393
30421
30444
30464
30484
30523
30551
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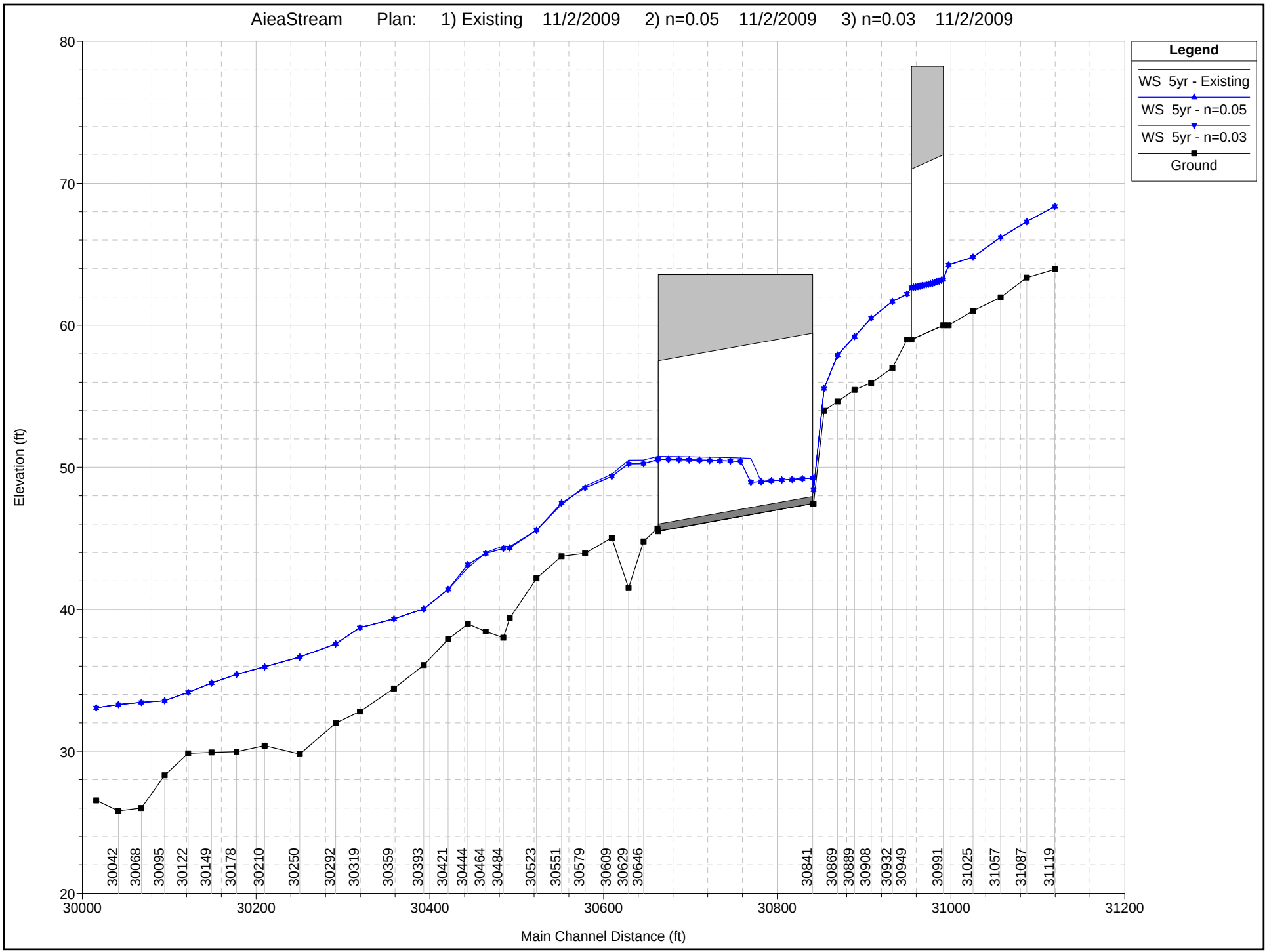
31057
31087
31119


AieaStream Plan: 1) Existing 11/2/2009 2) n=0.05 11/2/2009 3) n=0.03 11/2/2009
Legend
WS 5yr - Existing
WS 5yr - n=0.05
WS 5yr - n=0.03
Ground
Elevation (ft)
Main Channel Distance (ft)
80
70
60
50
40
30
20
30000
30200
30400
30600
30800
31000
31200
30042
30068
30095
30122
30149
30178
30210
30250
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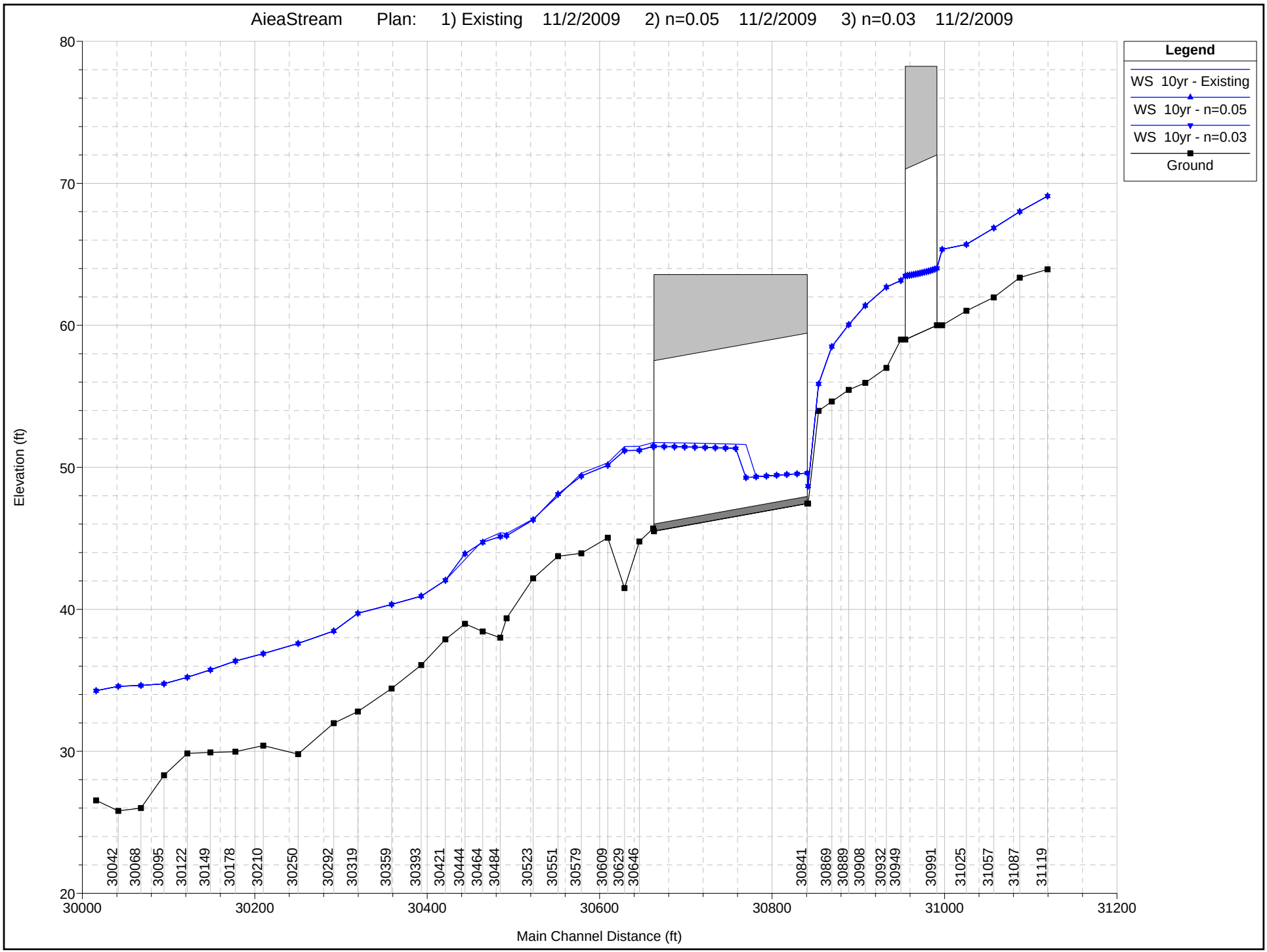
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Legend
WS 10yr - Existing
WS 10yr - n=0.05
WS 10yr - n=0.03
Ground
Elevation (ft)
Main Channel Distance (ft)
80
70
60
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30000
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30400
30600
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31000
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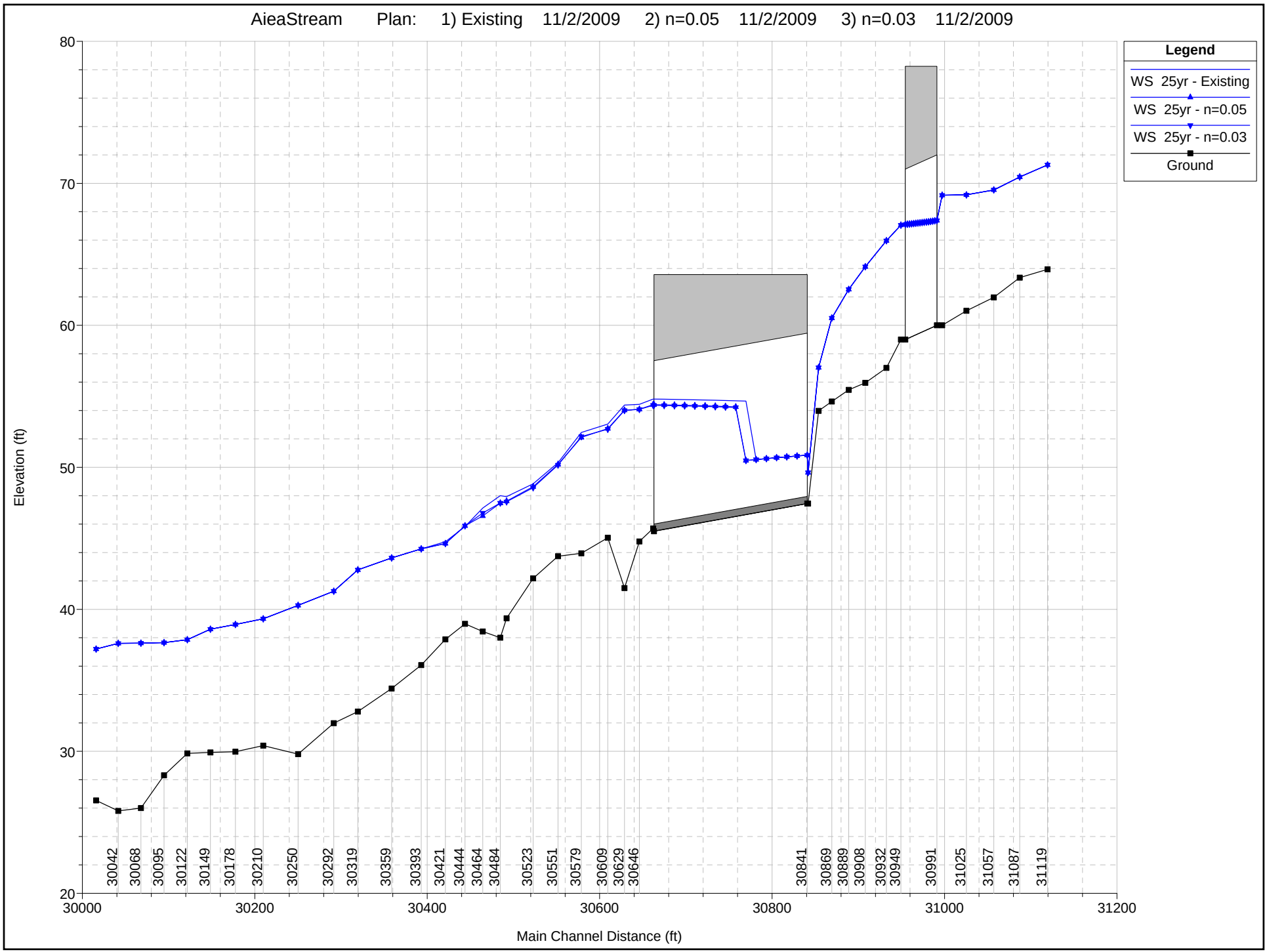
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Legend
WS 25yr - Existing
WS 25yr - n=0.05
WS 25yr - n=0.03
Ground
Elevation (ft)
Main Channel Distance (ft)
80
70
60
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30000
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30400
30600
30800
31000
31200
30042
30068
30095
30122
30149
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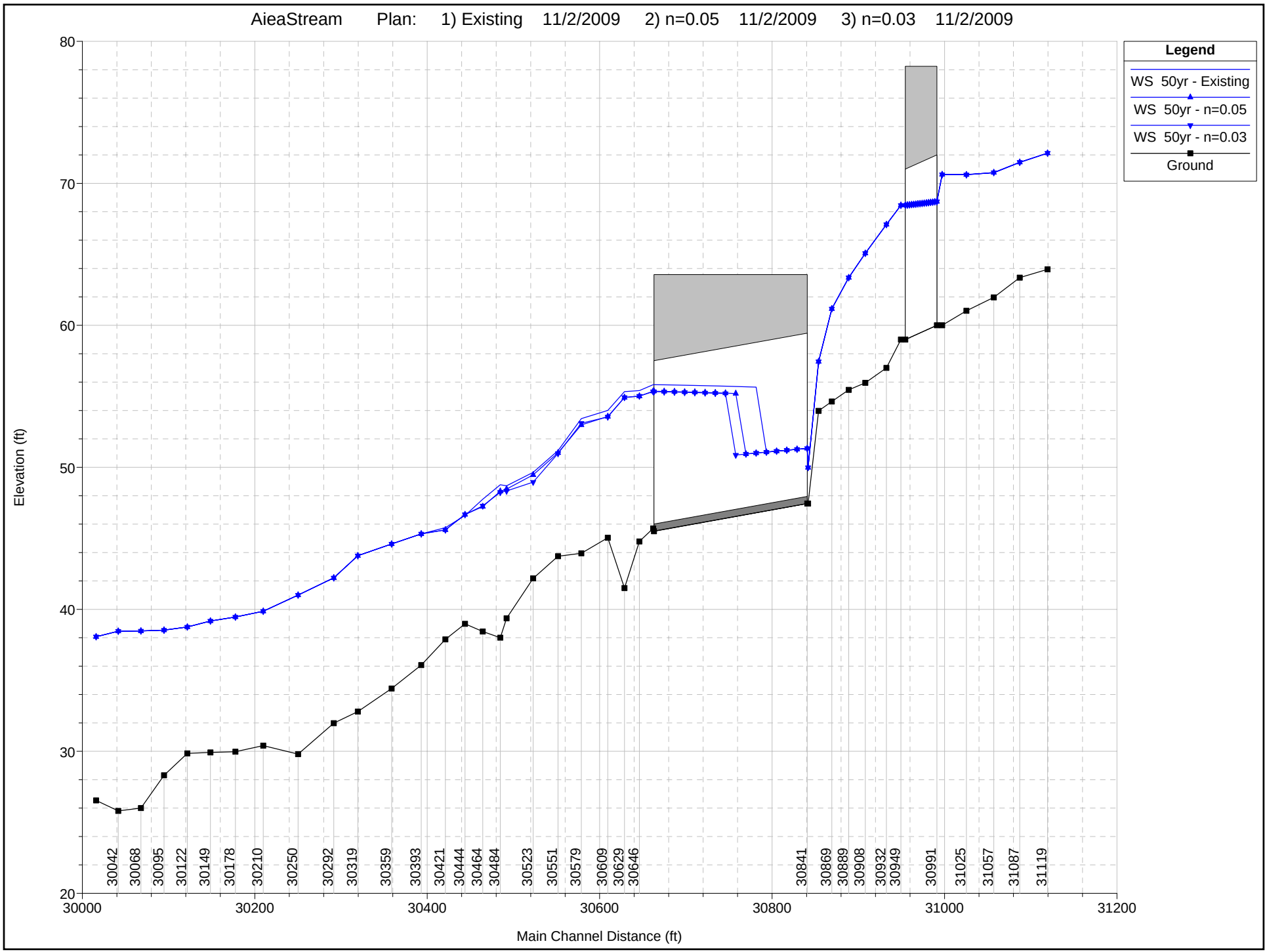
AieaStream Plan: 1) Existing 11/2/2009 2) n=0.05 11/2/2009 3) n=0.03 11/2/2009
Legend
WS 50yr - Existing
WS 50yr - n=0.05
WS 50yr - n=0.03
Ground
Elevation (ft)
Main Channel Distance (ft)
80
70
60
50
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30
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30000
30200
30400
30600
30800
31000
31200
30042
30068
30095
30122
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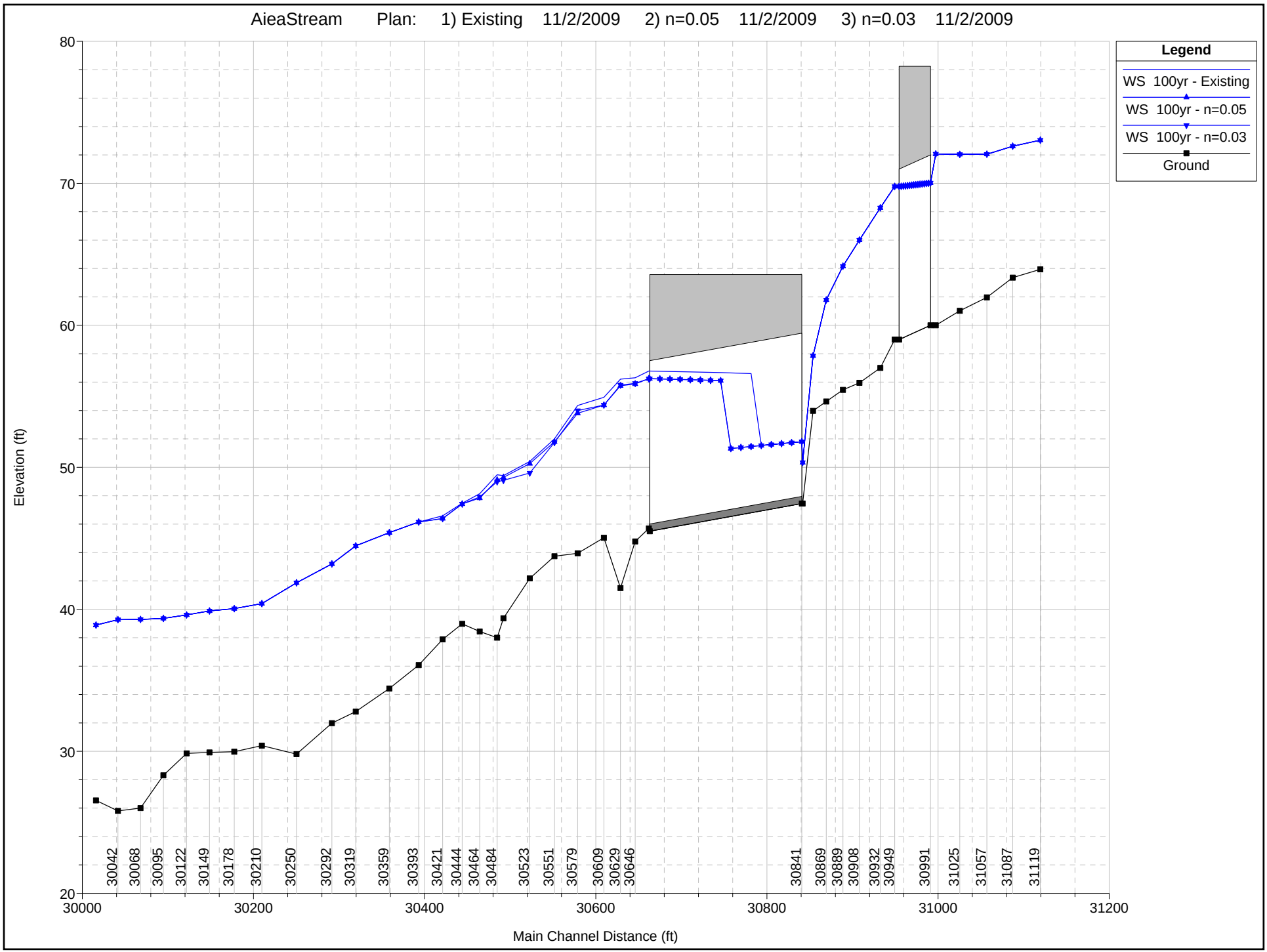
AieaStream Plan: 1) Existing 11/2/2009 2) n=0.05 11/2/2009 3) n=0.03 11/2/2009
Legend
WS 100yr - Existing
WS 100yr - n=0.05
WS 100yr - n=0.03
Ground
Elevation (ft)
Main Channel Distance (ft)
80
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30400
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31000
31200
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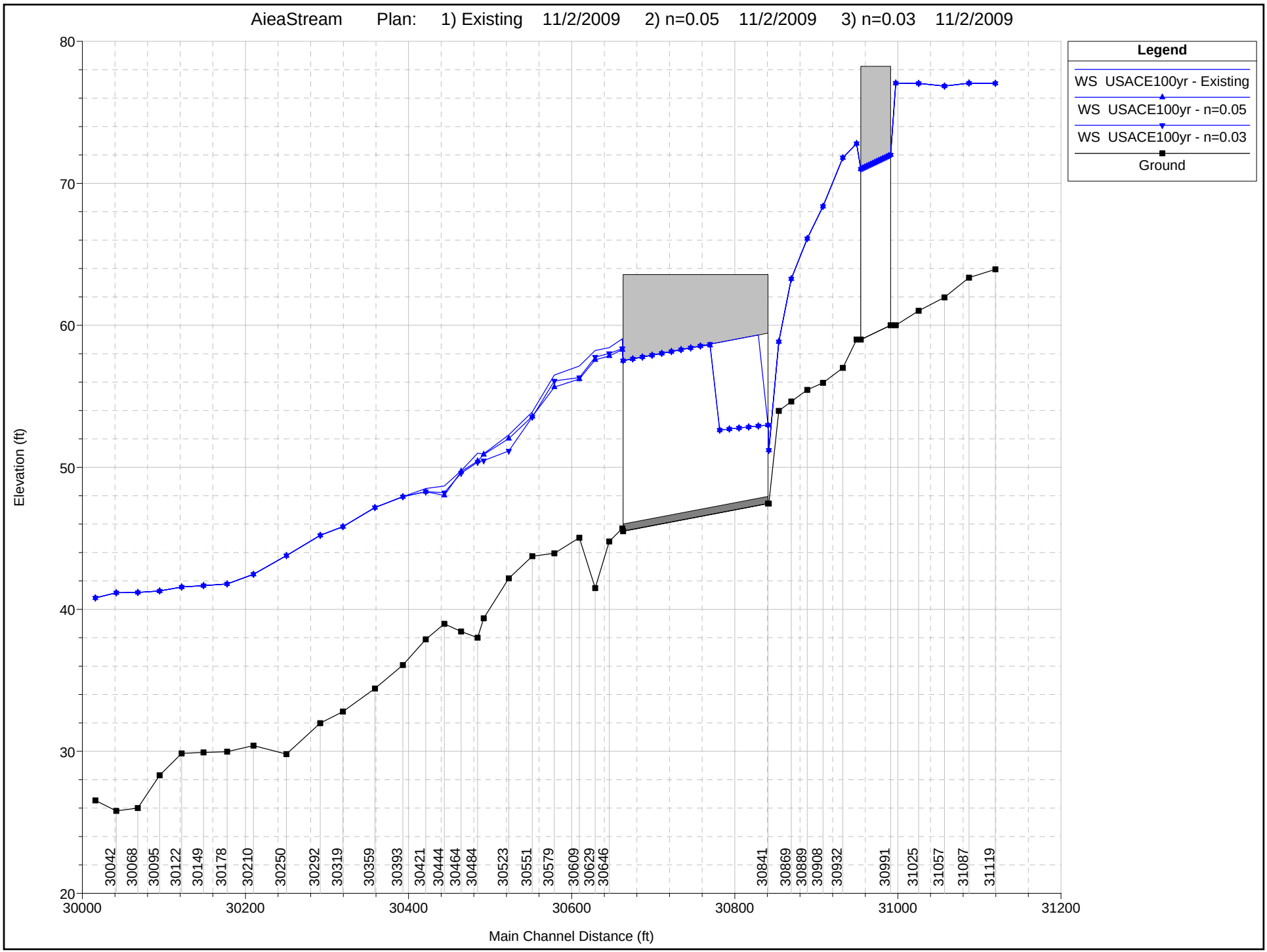
AieaStream Plan: 1) Existing 11/2/2009 2) n=0.05 11/2/2009 3) n=0.03 11/2/2009
Legend
WS USACE100yr - Existing
WS USACE100yr - n=0.05
WS USACE100yr - n=0.03
Ground
Elevation (ft)
Main Channel Distance (ft)
80
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60
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30000
30200
30400
30600
30800
31000
31200
30042
30068
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APPENDIX 16

HEC-RAS Model Results Table for Existing Condition

HEC-RAS Profile Output Table for Existing Condition: 2-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	2yr	375	63.94	75.75	75.64	67.32	66.56	67.89	0.017052	6.03	62.50	22.71	0.63
Aiea Stream	310+87	2yr	375	63.36	75.59	76.00	66.30	65.95	67.03	0.055442	6.87	54.59	23.97	0.80
Aiea Stream	310+57	2yr	375	61.97	74.77	74.51	65.19	64.45	65.75	0.025987	5.97	63.05	23.97	0.64
Aiea Stream	310+25	2yr	375	61.02	76.57	78.00	63.71	63.54	64.54	0.065028	7.33	51.19	24.34	0.89
Aiea Stream	309+97	2yr	375	60.00	76.05	76.01	62.69	62.34	63.37	0.015021	6.61	56.76	25.89	0.79
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	2yr	375	59.00	69.53	71.80	61.20	61.20	62.18	0.05712	7.95	47.19	24.13	1.00
Aiea Stream	309+32	2yr	375	57.00	67.00	71.56	60.28	59.74	61.13	0.033701	7.38	50.82	16.88	0.75
Aiea Stream	309+08	2yr	375	55.95	68.00	71.56	59.24	59.24	60.52	0.012042	9.08	41.29	16.32	1.01
Aiea Stream	308+89	2yr	375	55.45	66.42	71.56	58.16	58.66	60.12	0.022461	11.24	33.49	16.76	1.37
Aiea Stream	308+69	2yr	375	54.64	63.64	71.56	57.13	57.83	59.51	0.036132	12.38	30.29	18.68	1.70
Aiea Stream	308+54	2yr	375	53.98	60.90	71.56	55.10	55.92	58.25	0.098108	14.23	26.35	28.73	2.62
Aiea Stream	308+42	2yr	375	47.45	60.58	60.48	48.07	49.10	54.04	0.315347	19.61	19.12	31.07	4.41
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	2yr	375	45.70	57.64	60.00	49.38	48.11	49.63	0.010114	3.97	94.64	33.60	0.41
Aiea Stream	306+46	2yr	375	44.78	57.97	58.00	49.14	47.88	49.43	0.011259	4.32	87.66	31.66	0.45
Aiea Stream	306+29	2yr	375	41.50	57.93	62.00	49.12	45.43	49.25	0.002447	2.84	132.57	27.02	0.22
Aiea Stream	306+09	2yr	375	45.04	59.90	62.18	48.41	47.93	49.10	0.048683	6.66	57.27	24.62	0.73
Aiea Stream	305+79	2yr	375	43.94	58.80	59.99	47.50	46.80	48.04	0.016471	5.91	64.17	25.32	0.64
Aiea Stream	305+51	2yr	375	43.74	57.99	61.99	46.54	46.20	47.31	0.052981	7.05	53.75	23.25	0.80
Aiea Stream	305+23	2yr	375	42.18	58.00	59.98	44.55	44.46	45.43	0.082685	7.55	49.71	24.90	0.94
Aiea Stream	304+92	2yr	375	39.37	58.17	58.09	43.10	42.13	43.61	0.025814	5.71	66.37	22.43	0.57
Aiea Stream	304+84	2yr	375	38.00	58.00	58.05	43.12	41.23	43.43	0.007029	4.47	85.05	23.49	0.40
Aiea Stream	304+64	2yr	375	38.44	58.02	57.80	42.78	41.51	43.24	0.01202	5.41	70.18	21.54	0.51
Aiea Stream	304+44	2yr	375	38.98	48.21	56.10	42.01	41.62	42.77	0.056027	6.99	54.28	23.07	0.77
Aiea Stream	304+21	2yr	375	37.88	46.67	54.00	40.55	40.33	41.32	0.073468	7.08	54.25	28.02	0.83
Aiea Stream	303+93	2yr	375	36.07	46.36	55.00	38.99	38.89	39.81	0.033519	7.28	52.45	28.95	0.91
Aiea Stream	303+59	2yr	375	34.42	44.21	53.95	37.98	37.65	38.79	0.026077	7.22	53.77	25.03	0.79
Aiea Stream	303+19	2yr	375	32.80	42.83	50.15	37.29	36.41	37.91	0.015745	6.37	59.54	19.45	0.62
Aiea Stream	302+92	2yr	375	31.98	41.74	48.20	36.26	35.81	37.20	0.055468	7.79	49.15	17.56	0.78
Aiea Stream	302+50	2yr	375	29.80	40.81	45.50	35.23	33.39	35.62	0.010159	5.04	75.99	19.44	0.43
Aiea Stream	302+10	2yr	375	30.40	40.07	43.27	34.62	33.33	35.06	0.021706	5.28	71.09	20.55	0.50
Aiea Stream	301+78	2yr	375	29.98	39.79	43.21	34.10	32.51	34.44	0.014238	4.67	81.27	23.99	0.43
Aiea Stream	301+49	2yr	375	29.92	36.86	44.19	33.55	32.48	34.01	0.013594	5.43	70.80	25.34	0.54
Aiea Stream	301+22	2yr	375	29.85	37.33	44.56	32.81	32.25	33.45	0.038625	6.49	59.81	25.05	0.69
Aiea Stream	300+95	2yr	375	28.31	35.42	44.40	31.95	31.21	32.54	0.02715	6.23	62.89	24.61	0.64
Aiea Stream	300+68	2yr	375	26.00	34.44	43.24	31.72	29.36	31.95	0.006068	3.88	104.24	28.39	0.32
Aiea Stream	300+42	2yr	375	25.80	32.00	42.75	31.57	29.24	31.79	0.005867	3.86	106.41	29.31	0.32
Aiea Stream	300+16	2yr	375	26.54	33.39	42.75	31.35	29.18	31.62	0.007004	4.31	99.61	28.30	0.35

HEC-RAS Profile Output Table for Existing Condition: 5-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	5yr	669	63.94	75.75	75.64	68.38	67.56	69.33	0.01889	7.82	87.38	24.56	0.70
Aiea Stream	310+87	5yr	669	63.36	75.59	76.00	67.30	66.91	68.41	0.052458	8.48	79.79	26.18	0.83
Aiea Stream	310+57	5yr	669	61.97	74.77	74.51	66.19	65.44	67.13	0.029424	7.81	87.88	26.10	0.71
Aiea Stream	310+25	5yr	669	61.02	76.57	78.00	64.82	64.49	65.92	0.052111	8.40	80.05	27.37	0.84
Aiea Stream	309+97	5yr	669	60.00	76.05	76.01	64.25	63.27	64.96	0.00809	6.79	100.22	30.18	0.63
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	5yr	669	59.00	69.53	71.80	62.21	62.12	63.56	0.04551	9.33	71.90	24.67	0.96
Aiea Stream	309+32	5yr	669	57.00	67.00	71.56	61.68	61.04	62.85	0.028442	8.74	78.94	20.73	0.73
Aiea Stream	309+08	5yr	669	55.95	68.00	71.56	60.50	60.50	62.31	0.009937	10.80	63.68	21.88	0.98
Aiea Stream	308+89	5yr	669	55.45	66.42	71.56	59.21	59.87	61.95	0.018254	13.29	52.31	19.15	1.32
Aiea Stream	308+69	5yr	669	54.64	63.64	71.56	57.90	58.94	61.39	0.031608	14.99	45.57	20.79	1.70
Aiea Stream	308+54	5yr	669	53.98	60.90	71.56	55.54	56.74	60.14	0.087261	17.21	38.88	28.90	2.61
Aiea Stream	308+42	5yr	669	47.45	60.58	60.48	48.41	49.88	56.24	0.235393	22.45	29.79	31.07	4.04
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	5yr	669	45.70	57.64	60.00	50.76	48.86	51.11	0.008624	4.77	141.34	34.15	0.41
Aiea Stream	306+46	5yr	669	44.78	57.97	58.00	50.51	48.75	50.93	0.009682	5.19	132.14	32.92	0.44
Aiea Stream	306+29	5yr	669	41.50	57.93	62.00	50.50	46.55	50.75	0.003507	3.99	170.99	28.64	0.28
Aiea Stream	306+09	5yr	669	45.04	59.90	62.18	49.50	48.95	50.54	0.04667	8.25	86.24	28.44	0.76
Aiea Stream	305+79	5yr	669	43.94	58.80	59.99	48.68	47.74	49.50	0.015346	7.28	95.55	27.77	0.65
Aiea Stream	305+51	5yr	669	43.74	57.99	61.99	47.38	47.19	48.73	0.062781	9.34	73.66	24.43	0.91
Aiea Stream	305+23	5yr	669	42.18	58.00	59.98	45.58	45.38	46.80	0.067605	8.88	76.26	26.48	0.90
Aiea Stream	304+92	5yr	669	39.37	58.17	58.09	44.42	43.15	45.20	0.025083	7.11	96.99	24.15	0.59
Aiea Stream	304+84	5yr	669	38.00	58.00	58.05	44.46	42.31	45.00	0.008351	5.92	118.34	26.15	0.45
Aiea Stream	304+64	5yr	669	38.44	58.02	57.80	43.99	42.58	44.77	0.014028	7.11	97.87	24.37	0.58
Aiea Stream	304+44	5yr	669	38.98	48.21	56.10	42.92	42.64	44.20	0.063032	9.10	76.59	26.29	0.86
Aiea Stream	304+21	5yr	669	37.88	46.67	54.00	41.39	41.27	42.60	0.077147	8.96	78.92	30.89	0.90
Aiea Stream	303+93	5yr	669	36.07	46.36	55.00	40.04	39.77	41.11	0.025272	8.39	84.59	32.34	0.85
Aiea Stream	303+59	5yr	669	34.42	44.21	53.95	39.33	38.70	40.33	0.019236	8.20	88.40	26.47	0.73
Aiea Stream	303+19	5yr	669	32.80	42.83	50.15	38.71	37.54	39.65	0.01461	7.82	88.66	21.64	0.64
Aiea Stream	302+92	5yr	669	31.98	41.74	48.20	37.56	37.08	38.97	0.053036	9.63	73.59	20.03	0.81
Aiea Stream	302+50	5yr	669	29.80	40.81	45.50	36.64	34.60	37.33	0.012241	6.71	103.41	19.47	0.50
Aiea Stream	302+10	5yr	669	30.40	40.07	43.27	35.96	34.36	36.68	0.023407	6.81	98.61	20.69	0.55
Aiea Stream	301+78	5yr	669	29.98	39.79	43.21	35.42	33.52	35.98	0.015821	6.05	115.04	27.16	0.48
Aiea Stream	301+49	5yr	669	29.92	36.86	44.19	34.81	33.51	35.52	0.013795	6.83	104.96	29.09	0.57
Aiea Stream	301+22	5yr	669	29.85	37.33	44.56	34.15	33.27	35.00	0.030508	7.54	96.22	29.26	0.66
Aiea Stream	300+95	5yr	669	28.31	35.42	44.40	33.56	32.27	34.28	0.018979	6.95	107.46	30.18	0.57
Aiea Stream	300+68	5yr	669	26.00	34.44	43.24	33.44	30.42	33.79	0.006242	4.88	153.97	29.71	0.34
Aiea Stream	300+42	5yr	669	25.80	32.00	42.75	33.29	30.28	33.63	0.005878	4.79	176.34	57.76	0.34
Aiea Stream	300+16	5yr	669	26.54	33.39	42.75	33.06	30.30	33.46	0.006995	5.31	154.95	35.06	0.37

HEC-RAS Profile Output Table for Existing Condition: 10-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	10yr	919	63.94	75.75	75.64	69.10	68.28	70.36	0.020118	9.04	105.63	25.99	0.74
Aiea Stream	310+87	10yr	919	63.36	75.59	76.00	68.01	67.61	69.41	0.051286	9.55	98.77	27.69	0.84
Aiea Stream	310+57	10yr	919	61.97	74.77	74.51	66.84	66.15	68.12	0.032235	9.10	105.41	27.58	0.76
Aiea Stream	310+25	10yr	919	61.02	76.57	78.00	65.71	65.16	66.95	0.042021	8.93	105.41	29.77	0.79
Aiea Stream	309+97	10yr	919	60.00	76.05	76.01	65.35	63.91	66.13	0.006253	7.12	135.25	33.21	0.57
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	10yr	919	59.00	69.53	71.80	63.16	62.80	64.62	0.034013	9.70	95.50	25.17	0.86
Aiea Stream	309+32	10yr	919	57.00	67.00	71.56	62.70	61.85	64.07	0.025877	9.57	99.95	20.75	0.72
Aiea Stream	309+08	10yr	919	55.95	68.00	71.56	61.39	61.39	63.57	0.009124	11.90	83.50	22.82	0.97
Aiea Stream	308+89	10yr	919	55.45	66.42	71.56	60.05	60.84	63.23	0.015555	14.36	69.06	21.05	1.27
Aiea Stream	308+69	10yr	919	54.64	63.64	71.56	58.50	59.75	62.69	0.028407	16.47	58.49	22.44	1.67
Aiea Stream	308+54	10yr	919	53.98	60.90	71.56	55.87	57.34	61.45	0.078953	18.96	48.51	29.02	2.58
Aiea Stream	308+42	10yr	919	47.45	60.58	60.48	48.68	50.45	57.70	0.199467	24.10	38.13	31.07	3.83
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	10yr	919	45.70	57.64	60.00	51.75	49.41	52.18	0.008074	5.31	175.24	34.54	0.41
Aiea Stream	306+46	10yr	919	44.78	57.97	58.00	51.48	49.33	52.00	0.009167	5.79	164.21	33.31	0.45
Aiea Stream	306+29	10yr	919	41.50	57.93	62.00	51.47	47.31	51.82	0.00416	4.77	199.17	29.74	0.31
Aiea Stream	306+09	10yr	919	45.04	59.90	62.18	50.32	49.68	51.58	0.043906	9.14	110.59	31.23	0.76
Aiea Stream	305+79	10yr	919	43.94	58.80	59.99	49.58	48.44	50.58	0.01428	8.07	121.40	29.88	0.65
Aiea Stream	305+51	10yr	919	43.74	57.99	61.99	47.97	47.91	49.78	0.067733	10.84	88.40	25.51	0.97
Aiea Stream	305+23	10yr	919	42.18	58.00	59.98	46.36	46.05	47.81	0.05929	9.68	97.28	27.54	0.87
Aiea Stream	304+92	10yr	919	39.37	58.17	58.09	45.34	43.91	46.33	0.024852	8.02	119.83	25.34	0.61
Aiea Stream	304+84	10yr	919	38.00	58.00	58.05	45.40	43.05	46.12	0.009074	6.88	143.64	28.00	0.49
Aiea Stream	304+64	10yr	919	38.44	58.02	57.80	44.84	43.37	45.86	0.01492	8.20	119.50	26.38	0.61
Aiea Stream	304+44	10yr	919	38.98	48.21	56.10	43.51	43.40	45.22	0.069267	10.60	92.89	29.14	0.93
Aiea Stream	304+21	10yr	919	37.88	46.67	54.00	42.04	41.93	43.51	0.073255	9.93	99.97	33.05	0.90
Aiea Stream	303+93	10yr	919	36.07	46.36	55.00	40.93	40.41	42.10	0.019581	8.78	114.39	34.11	0.78
Aiea Stream	303+59	10yr	919	34.42	44.21	53.95	40.34	39.41	41.48	0.016221	8.78	116.12	27.90	0.70
Aiea Stream	303+19	10yr	919	32.80	42.83	50.15	39.72	38.37	40.89	0.014109	8.76	111.43	23.59	0.65
Aiea Stream	302+92	10yr	919	31.98	41.74	48.20	38.47	37.99	40.21	0.051707	10.78	92.68	21.85	0.82
Aiea Stream	302+50	10yr	919	29.80	40.81	45.50	37.60	35.43	38.55	0.013645	7.87	122.03	19.49	0.54
Aiea Stream	302+10	10yr	919	30.40	40.07	43.27	36.88	35.12	37.83	0.024644	7.85	117.69	20.78	0.58
Aiea Stream	301+78	10yr	919	29.98	39.79	43.21	36.36	34.27	37.08	0.016323	6.89	142.19	31.32	0.50
Aiea Stream	301+49	10yr	919	29.92	36.86	44.19	35.74	34.25	36.62	0.01336	7.64	133.35	37.60	0.58
Aiea Stream	301+22	10yr	919	29.85	37.33	44.56	35.22	34.01	36.14	0.025002	7.97	129.56	32.93	0.62
Aiea Stream	300+95	10yr	919	28.31	35.42	44.40	34.75	33.04	35.54	0.015591	7.35	144.73	32.42	0.54
Aiea Stream	300+68	10yr	919	26.00	34.44	43.24	34.64	31.20	35.12	0.006637	5.66	194.64	63.56	0.37
Aiea Stream	300+42	10yr	919	25.80	32.00	42.75	34.58	31.02	34.92	0.00512	5.07	267.88	84.22	0.33
Aiea Stream	300+16	10yr	919	26.54	33.39	42.75	34.27	31.09	34.76	0.007004	5.98	205.54	53.13	0.38

HEC-RAS Profile Output Table for Existing Condition: 25-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	25yr	1916	63.94	75.75	75.64	71.30	70.71	73.70	0.023246	12.58	167.44	30.34	0.85
Aiea Stream	310+87	25yr	1916	63.36	75.59	76.00	70.44	69.87	72.67	0.043618	12.11	173.30	33.45	0.84
Aiea Stream	310+57	25yr	1916	61.97	74.77	74.51	69.52	68.49	71.53	0.027494	11.54	187.56	33.75	0.76
Aiea Stream	310+25	25yr	1916	61.02	76.57	78.00	69.21	67.34	70.57	0.020798	9.57	226.48	39.50	0.62
Aiea Stream	309+97	25yr	1916	60.00	76.05	76.01	69.16	66.03	70.10	0.003569	7.96	281.71	43.58	0.48
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	25yr	1916	59.00	69.53	71.80	67.06	65.05	68.61	0.014529	10.06	197.64	27.22	0.63
Aiea Stream	309+32	25yr	1916	57.00	67.00	71.56	65.96	64.36	68.13	0.022201	12.14	167.78	20.79	0.73
Aiea Stream	309+08	25yr	1916	55.95	68.00	71.56	64.13	64.13	67.63	0.008137	15.28	150.03	25.75	0.99
Aiea Stream	308+89	25yr	1916	55.45	66.42	71.56	62.53	63.58	67.31	0.012548	17.85	134.60	28.53	1.24
Aiea Stream	308+69	25yr	1916	54.64	63.64	71.56	60.51	62.38	66.82	0.02185	20.31	110.53	31.02	1.60
Aiea Stream	308+54	25yr	1916	53.98	60.90	71.56	57.02	59.33	65.53	0.059878	23.41	82.31	29.44	2.45
Aiea Stream	308+42	25yr	1916	47.45	60.58	60.48	49.63	52.35	62.01	0.136623	28.23	67.86	31.08	3.37
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	25yr	1916	45.70	57.64	60.00	54.81	51.23	55.56	0.007483	6.96	282.82	35.71	0.43
Aiea Stream	306+46	25yr	1916	44.78	57.97	58.00	54.44	51.26	55.34	0.008821	7.66	265.41	35.27	0.47
Aiea Stream	306+29	25yr	1916	41.50	57.93	62.00	54.38	49.55	55.16	0.005957	7.10	288.66	31.60	0.39
Aiea Stream	306+09	25yr	1916	45.04	59.90	62.18	53.04	51.99	54.86	0.035311	11.24	207.32	39.61	0.74
Aiea Stream	305+79	25yr	1916	43.94	58.80	59.99	52.46	50.72	54.03	0.012289	10.25	216.96	36.55	0.65
Aiea Stream	305+51	25yr	1916	43.74	57.99	61.99	50.33	50.33	53.22	0.058304	13.81	154.82	31.30	0.98
Aiea Stream	305+23	25yr	1916	42.18	58.00	59.98	48.84	48.26	51.06	0.047227	12.06	170.67	32.27	0.85
Aiea Stream	304+92	25yr	1916	39.37	58.17	58.09	47.94	46.36	49.74	0.02762	11.00	189.88	28.70	0.69
Aiea Stream	304+84	25yr	1916	38.00	58.00	58.05	48.01	45.53	49.51	0.011885	9.95	223.38	33.04	0.59
Aiea Stream	304+64	25yr	1916	38.44	58.02	57.80	47.13	45.96	49.16	0.019164	11.70	187.79	33.75	0.74
Aiea Stream	304+44	25yr	1916	38.98	48.21	56.10	45.83	45.83	48.44	0.060327	13.38	172.86	39.34	0.93
Aiea Stream	304+21	25yr	1916	37.88	46.67	54.00	44.76	43.98	46.53	0.044874	11.18	199.53	40.21	0.78
Aiea Stream	303+93	25yr	1916	36.07	46.36	55.00	44.25	42.44	45.60	0.010259	9.57	236.68	39.50	0.63
Aiea Stream	303+59	25yr	1916	34.42	44.21	53.95	43.62	41.73	45.20	0.011853	10.54	212.67	31.24	0.65
Aiea Stream	303+19	25yr	1916	32.80	42.83	50.15	42.78	41.10	44.69	0.013422	11.39	193.24	29.87	0.68
Aiea Stream	302+92	25yr	1916	31.98	41.74	48.20	41.28	40.88	44.02	0.048618	13.86	162.14	27.71	0.86
Aiea Stream	302+50	25yr	1916	29.80	40.81	45.50	40.28	38.11	42.35	0.018909	11.63	174.38	19.54	0.67
Aiea Stream	302+10	25yr	1916	30.40	40.07	43.27	39.33	37.63	41.37	0.03259	11.45	169.14	21.69	0.71
Aiea Stream	301+78	25yr	1916	29.98	39.79	43.21	38.93	36.74	40.24	0.019194	9.51	231.68	74.02	0.57
Aiea Stream	301+49	25yr	1916	29.92	36.86	44.19	38.60	36.61	39.74	0.011013	9.22	326.40	135.18	0.57
Aiea Stream	301+22	25yr	1916	29.85	37.33	44.56	37.86	36.23	39.30	0.023734	10.24	255.30	124.46	0.65
Aiea Stream	300+95	25yr	1916	28.31	35.42	44.40	37.65	35.30	38.62	0.012842	8.75	338.83	128.17	0.52
Aiea Stream	300+68	25yr	1916	26.00	34.44	43.24	37.62	33.47	38.21	0.00632	6.91	432.58	142.64	0.38
Aiea Stream	300+42	25yr	1916	25.80	32.00	42.75	37.60	33.76	38.01	0.004629	6.04	523.00	142.19	0.33
Aiea Stream	300+16	25yr	1916	26.54	33.39	42.75	37.21	33.30	37.85	0.007004	7.44	431.45	111.80	0.41

HEC-RAS Profile Output Table for Existing Condition: 50-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	50yr	2321	63.94	75.75	75.64	72.12	71.55	74.87	0.022978	13.50	193.22	31.98	0.86
Aiea Stream	310+87	50yr	2321	63.36	75.59	76.00	71.47	70.66	73.83	0.038206	12.52	208.68	35.30	0.81
Aiea Stream	310+57	50yr	2321	61.97	74.77	74.51	70.74	69.30	72.82	0.023242	11.80	230.61	36.83	0.72
Aiea Stream	310+25	50yr	2321	61.02	76.57	78.00	70.62	68.09	71.97	0.016498	9.57	285.30	43.44	0.57
Aiea Stream	309+97	50yr	2321	60.00	76.05	76.01	70.62	66.76	71.58	0.003011	8.12	347.71	47.13	0.45
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	50yr	2321	59.00	69.53	71.80	68.45	65.83	70.08	0.012241	10.30	236.22	27.96	0.60
Aiea Stream	309+32	50yr	2321	57.00	67.00	71.56	67.10	65.26	69.57	0.021517	12.97	192.75	26.99	0.73
Aiea Stream	309+08	50yr	2321	55.95	68.00	71.56	65.07	65.07	69.06	0.00794	16.34	174.77	26.76	1.00
Aiea Stream	308+89	50yr	2321	55.45	66.42	71.56	63.36	64.51	68.73	0.01212	19.01	158.60	29.57	1.24
Aiea Stream	308+69	50yr	2321	54.64	63.64	71.56	61.16	63.24	68.23	0.021011	21.60	131.10	32.21	1.60
Aiea Stream	308+54	50yr	2321	53.98	60.90	71.56	57.44	60.04	66.92	0.055635	24.72	94.61	29.60	2.42
Aiea Stream	308+42	50yr	2321	47.45	60.58	60.48	49.99	53.02	63.44	0.124825	29.43	78.85	31.08	3.26
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	50yr	2321	45.70	57.64	60.00	55.82	51.87	56.69	0.007461	7.51	319.20	36.10	0.43
Aiea Stream	306+46	50yr	2321	44.78	57.97	58.00	55.40	51.93	56.45	0.00889	8.29	299.79	35.94	0.48
Aiea Stream	306+29	50yr	2321	41.50	57.93	62.00	55.33	50.33	56.28	0.006519	7.88	318.81	32.21	0.41
Aiea Stream	306+09	50yr	2321	45.04	59.90	62.18	54.00	52.78	55.97	0.032923	11.80	246.76	42.53	0.73
Aiea Stream	305+79	50yr	2321	43.94	58.80	59.99	53.43	51.51	55.21	0.011877	10.92	253.69	38.77	0.66
Aiea Stream	305+51	50yr	2321	43.74	57.99	61.99	51.17	51.17	54.39	0.055011	14.61	182.56	34.04	0.97
Aiea Stream	305+23	50yr	2321	42.18	58.00	59.98	49.65	49.05	52.16	0.045828	12.87	197.51	34.33	0.85
Aiea Stream	304+92	50yr	2321	39.37	58.17	58.09	48.70	47.20	50.86	0.029399	12.07	212.22	29.71	0.72
Aiea Stream	304+84	50yr	2321	38.00	58.00	58.05	48.77	46.38	50.61	0.013098	11.04	249.19	34.49	0.63
Aiea Stream	304+64	50yr	2321	38.44	58.02	57.80	47.75	46.91	50.22	0.021344	12.98	209.28	35.86	0.79
Aiea Stream	304+44	50yr	2321	38.98	48.21	56.10	46.61	46.61	49.49	0.058153	14.18	204.42	41.99	0.94
Aiea Stream	304+21	50yr	2321	37.88	46.67	54.00	45.75	44.68	47.61	0.039301	11.52	240.95	43.24	0.74
Aiea Stream	303+93	50yr	2321	36.07	46.36	55.00	45.31	43.15	46.78	0.009387	10.03	279.43	41.21	0.61
Aiea Stream	303+59	50yr	2321	34.42	44.21	53.95	44.61	42.53	46.40	0.011633	11.27	251.29	54.76	0.65
Aiea Stream	303+19	50yr	2321	32.80	42.83	50.15	43.78	42.05	45.89	0.013138	12.11	237.68	67.68	0.68
Aiea Stream	302+92	50yr	2321	31.98	41.74	48.20	42.21	42.21	45.23	0.047173	14.68	195.80	54.18	0.86
Aiea Stream	302+50	50yr	2321	29.80	40.81	45.50	41.00	39.07	43.62	0.021564	13.07	190.23	33.25	0.73
Aiea Stream	302+10	50yr	2321	30.40	40.07	43.27	39.86	38.51	42.50	0.038822	13.03	180.97	40.42	0.78
Aiea Stream	301+78	50yr	2321	29.98	39.79	43.21	39.46	37.57	41.11	0.02252	10.72	252.24	99.92	0.63
Aiea Stream	301+49	50yr	2321	29.92	36.86	44.19	39.18	38.07	40.47	0.011859	10.01	380.75	154.58	0.59
Aiea Stream	301+22	50yr	2321	29.85	37.33	44.56	38.75	37.00	40.07	0.020224	10.16	339.48	153.64	0.61
Aiea Stream	300+95	50yr	2321	28.31	35.42	44.40	38.53	37.01	39.49	0.011867	8.97	413.61	158.56	0.51
Aiea Stream	300+68	50yr	2321	26.00	34.44	43.24	38.48	34.25	39.12	0.006432	7.35	503.11	165.25	0.39
Aiea Stream	300+42	50yr	2321	25.80	32.00	42.75	38.46	34.79	38.92	0.004798	6.48	595.15	158.58	0.34
Aiea Stream	300+16	50yr	2321	26.54	33.39	42.75	38.07	34.72	38.75	0.007001	7.84	506.07	129.07	0.41

HEC-RAS Profile Output Table for Existing Condition: 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	100yr	2743	63.94	75.75	75.64	73.03	72.36	76.03	0.021725	14.15	223.17	33.94	0.85
Aiea Stream	310+87	100yr	2743	63.36	75.59	76.00	72.61	71.40	75.01	0.032541	12.70	249.91	37.26	0.76
Aiea Stream	310+57	100yr	2743	61.97	74.77	74.51	72.04	70.05	74.14	0.019484	11.91	280.14	39.33	0.68
Aiea Stream	310+25	100yr	2743	61.02	76.57	78.00	72.06	68.82	73.38	0.013475	9.56	350.51	47.39	0.52
Aiea Stream	309+97	100yr	2743	60.00	76.05	76.01	72.07	67.48	73.05	0.0026	8.25	418.78	50.75	0.43
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	100yr	2743	59.00	69.53	71.80	69.78	66.59	71.51	0.010869	10.62	273.86	29.49	0.58
Aiea Stream	309+32	100yr	2743	57.00	67.00	71.56	68.28	66.13	70.98	0.020375	13.61	225.73	31.07	0.72
Aiea Stream	309+08	100yr	2743	55.95	68.00	71.56	66.01	66.01	70.46	0.007731	17.31	200.24	27.77	1.00
Aiea Stream	308+89	100yr	2743	55.45	66.42	71.56	64.17	65.44	70.12	0.011757	20.09	182.90	30.58	1.24
Aiea Stream	308+69	100yr	2743	54.64	63.64	71.56	61.79	64.12	69.62	0.020372	22.82	151.71	33.36	1.60
Aiea Stream	308+54	100yr	2743	53.98	60.90	71.56	57.85	60.72	68.28	0.052244	25.93	106.80	29.75	2.39
Aiea Stream	308+42	100yr	2743	47.45	60.58	60.48	50.34	53.68	64.83	0.115695	30.54	89.81	31.08	3.17
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	100yr	2743	45.70	57.64	60.00	56.78	52.49	57.78	0.007503	8.03	354.13	36.90	0.44
Aiea Stream	306+46	100yr	2743	44.78	57.97	58.00	56.31	52.57	57.52	0.009033	8.90	332.59	36.54	0.49
Aiea Stream	306+29	100yr	2743	41.50	57.93	62.00	56.21	51.07	57.35	0.007072	8.62	347.47	32.81	0.43
Aiea Stream	306+09	100yr	2743	45.04	59.90	62.18	54.93	53.54	57.03	0.030971	12.29	287.35	44.84	0.72
Aiea Stream	305+79	100yr	2743	43.94	58.80	59.99	54.36	52.28	56.33	0.011617	11.56	290.49	40.88	0.66
Aiea Stream	305+51	100yr	2743	43.74	57.99	61.99	52.01	52.01	55.51	0.052115	15.31	211.87	36.47	0.96
Aiea Stream	305+23	100yr	2743	42.18	58.00	59.98	50.42	49.81	53.22	0.044804	13.63	224.72	36.34	0.86
Aiea Stream	304+92	100yr	2743	39.37	58.17	58.09	49.41	48.03	51.94	0.03115	13.09	233.74	30.66	0.75
Aiea Stream	304+84	100yr	2743	38.00	58.00	58.05	49.47	47.22	51.68	0.014346	12.11	274.18	36.98	0.67
Aiea Stream	304+64	100yr	2743	38.44	58.02	57.80	48.14	47.77	51.22	0.025252	14.55	223.56	37.19	0.86
Aiea Stream	304+44	100yr	2743	38.98	48.21	56.10	47.47	47.47	50.49	0.05334	14.66	241.92	44.92	0.91
Aiea Stream	304+21	100yr	2743	37.88	46.67	54.00	46.58	45.35	48.59	0.037453	12.06	277.93	46.01	0.74
Aiea Stream	303+93	100yr	2743	36.07	46.36	55.00	46.15	43.83	47.80	0.009417	10.70	314.26	42.56	0.62
Aiea Stream	303+59	100yr	2743	34.42	44.21	53.95	45.40	43.32	47.41	0.011907	12.05	292.20	80.53	0.67
Aiea Stream	303+19	100yr	2743	32.80	42.83	50.15	44.47	43.10	46.88	0.013988	13.07	272.63	93.40	0.71
Aiea Stream	302+92	100yr	2743	31.98	41.74	48.20	43.20	43.18	46.23	0.042943	15.01	243.13	87.93	0.83
Aiea Stream	302+50	100yr	2743	29.80	40.81	45.50	41.87	40.02	44.86	0.022335	14.05	230.48	66.91	0.75
Aiea Stream	302+10	100yr	2743	30.40	40.07	43.27	40.40	39.39	43.62	0.043975	14.44	203.47	74.10	0.84
Aiea Stream	301+78	100yr	2743	29.98	39.79	43.21	40.05	38.33	42.00	0.024785	11.73	287.80	130.71	0.67
Aiea Stream	301+49	100yr	2743	29.92	36.86	44.19	39.89	38.70	41.23	0.011565	10.41	448.17	177.27	0.59
Aiea Stream	301+22	100yr	2743	29.85	37.33	44.56	39.61	37.15	40.82	0.017573	10.08	420.15	181.55	0.58
Aiea Stream	300+95	100yr	2743	28.31	35.42	44.40	39.36	37.54	40.33	0.011183	9.21	484.40	187.32	0.50
Aiea Stream	300+68	100yr	2743	26.00	34.44	43.24	39.29	34.18	39.98	0.006532	7.76	570.19	186.74	0.39
Aiea Stream	300+42	100yr	2743	25.80	32.00	42.75	39.27	35.36	39.78	0.004956	6.90	663.71	174.16	0.35
Aiea Stream	300+16	100yr	2743	26.54	33.39	42.75	38.89	35.69	39.61	0.007006	8.22	577.01	145.48	0.42

HEC-RAS Profile Output Table for Existing Condition: USACE 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	USACE100yr	3850	63.94	75.75	75.64	77.03	74.31	79.47	0.011009	13.00	377.08	41.28	0.65
Aiea Stream	310+87	USACE100yr	3850	63.36	75.59	76.00	77.05	73.18	78.89	0.01473	11.29	432.14	43.17	0.55
Aiea Stream	310+57	USACE100yr	3850	61.97	74.77	74.51	76.84	71.96	78.46	0.009126	10.68	486.77	44.43	0.50
Aiea Stream	310+25	USACE100yr	3850	61.02	76.57	78.00	77.05	70.54	78.03	0.006248	8.46	621.38	61.00	0.38
Aiea Stream	309+97	USACE100yr	3850	60.00	76.05	76.01	77.06	69.17	77.87	0.001386	7.66	699.60	59.56	0.33
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	USACE100yr	3850	59.00	69.53	71.80	72.80	68.46	74.75	0.00892	11.38	381.88	43.86	0.54
Aiea Stream	309+32	USACE100yr	3850	57.00	67.00	71.56	71.80	68.78	74.38	0.014196	13.67	361.97	40.56	0.63
Aiea Stream	309+08	USACE100yr	3850	55.95	68.00	71.56	68.38	68.38	73.83	0.00704	19.22	274.23	36.22	0.99
Aiea Stream	308+89	USACE100yr	3850	55.45	66.42	71.56	66.11	67.69	73.47	0.011041	22.46	244.60	33.19	1.25
Aiea Stream	308+69	USACE100yr	3850	54.64	63.64	71.56	63.28	66.07	72.94	0.019213	25.52	203.81	36.51	1.61
Aiea Stream	308+54	USACE100yr	3850	53.98	60.90	71.56	58.85	62.45	71.53	0.046177	28.61	136.55	30.11	2.34
Aiea Stream	308+42	USACE100yr	3850	47.45	60.58	60.48	51.20	55.26	68.12	0.095387	33.01	116.63	31.08	3.00
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	USACE100yr	3850	45.70	57.64	60.00	59.05	54.01	60.35	0.007546	9.21	445.62	46.76	0.46
Aiea Stream	306+46	USACE100yr	3850	44.78	57.97	58.00	58.43	54.19	60.03	0.009327	10.28	412.75	42.26	0.52
Aiea Stream	306+29	USACE100yr	3850	41.50	57.93	62.00	58.23	52.87	59.88	0.008339	10.37	416.67	44.38	0.48
Aiea Stream	306+09	USACE100yr	3850	45.04	59.90	62.18	57.14	55.29	59.55	0.027585	13.40	393.87	53.30	0.70
Aiea Stream	305+79	USACE100yr	3850	43.94	58.80	59.99	56.50	54.09	58.95	0.0112	12.99	385.62	47.77	0.67
Aiea Stream	305+51	USACE100yr	3850	43.74	57.99	61.99	53.90	53.90	58.11	0.047948	16.95	286.43	42.45	0.95
Aiea Stream	305+23	USACE100yr	3850	42.18	58.00	59.98	52.28	51.64	55.69	0.041819	15.18	297.30	41.42	0.86
Aiea Stream	304+92	USACE100yr	3850	39.37	58.17	58.09	50.96	49.88	54.48	0.035933	15.55	283.63	34.81	0.83
Aiea Stream	304+84	USACE100yr	3850	38.00	58.00	58.05	50.99	49.13	54.18	0.017479	14.65	334.22	42.10	0.75
Aiea Stream	304+64	USACE100yr	3850	38.44	58.02	57.80	49.76	49.76	53.68	0.026575	16.69	287.99	42.67	0.91
Aiea Stream	304+44	USACE100yr	3850	38.98	48.21	56.10	48.68	49.33	52.75	0.061315	17.26	301.32	57.42	1.00
Aiea Stream	304+21	USACE100yr	3850	37.88	46.67	54.00	48.51	47.16	50.70	0.032561	12.93	399.66	84.09	0.71
Aiea Stream	303+93	USACE100yr	3850	36.07	46.36	55.00	47.93	45.47	50.10	0.009907	12.37	416.00	76.71	0.66
Aiea Stream	303+59	USACE100yr	3850	34.42	44.21	53.95	47.17	45.62	49.70	0.01254	13.78	386.41	138.97	0.71
Aiea Stream	303+19	USACE100yr	3850	32.80	42.83	50.15	45.82	45.41	49.08	0.016731	15.51	344.01	143.88	0.80
Aiea Stream	302+92	USACE100yr	3850	31.98	41.74	48.20	45.21	44.97	48.41	0.038423	16.03	345.59	156.82	0.81
Aiea Stream	302+50	USACE100yr	3850	29.80	40.81	45.50	43.78	43.78	47.14	0.021765	15.46	349.40	157.27	0.76
Aiea Stream	302+10	USACE100yr	3850	30.40	40.07	43.27	42.47	42.47	45.94	0.038614	15.47	314.47	168.14	0.81
Aiea Stream	301+78	USACE100yr	3850	29.98	39.79	43.21	41.78	41.03	43.80	0.02258	12.50	440.66	211.46	0.65
Aiea Stream	301+49	USACE100yr	3850	29.92	36.86	44.19	41.67	39.97	43.08	0.010513	11.13	616.62	230.67	0.58
Aiea Stream	301+22	USACE100yr	3850	29.85	37.33	44.56	41.57	39.75	42.66	0.013696	10.09	606.71	237.53	0.52
Aiea Stream	300+95	USACE100yr	3850	28.31	35.42	44.40	41.29	38.70	42.31	0.01012	9.82	648.44	241.77	0.49
Aiea Stream	300+68	USACE100yr	3850	26.00	34.44	43.24	41.19	37.38	42.00	0.006713	8.67	726.53	227.20	0.41
Aiea Stream	300+42	USACE100yr	3850	25.80	32.00	42.75	41.17	36.50	41.79	0.005275	7.83	823.45	209.00	0.37
Aiea Stream	300+16	USACE100yr	3850	26.54	33.39	42.75	40.81	37.27	41.62	0.007003	9.06	742.38	183.74	0.43

APPENDIX 17

HEC-RAS Model Results Table for Proposed Condition n=0.03

HEC-RAS Profile Output Table for Shotcrete Wall n=0.03: 2-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	2yr	375	63.94	75.75	75.64	67.32	66.56	67.89	0.02	6.03	62.50	22.71	0.63
Aiea Stream	310+87	2yr	375	63.36	75.59	76.00	66.30	65.95	67.03	0.06	6.87	54.59	23.97	0.80
Aiea Stream	310+57	2yr	375	61.97	74.77	74.51	65.19	64.45	65.75	0.03	5.98	63.04	23.97	0.64
Aiea Stream	310+25	2yr	375	61.02	76.57	78.00	63.71	63.54	64.54	0.06	7.34	51.11	24.33	0.89
Aiea Stream	309+97	2yr	375	60.00	76.05	76.01	62.69	62.34	63.37	0.02	6.61	56.76	25.89	0.79
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	2yr	375	59.00	69.53	71.80	61.20	61.20	62.18	0.06	7.95	47.19	24.13	1.00
Aiea Stream	309+32	2yr	375	57.00	67.00	71.56	60.28	59.74	61.13	0.03	7.38	50.82	16.88	0.75
Aiea Stream	309+08	2yr	375	55.95	68.00	71.56	59.24	59.24	60.52	0.01	9.08	41.29	16.32	1.01
Aiea Stream	308+89	2yr	375	55.45	66.42	71.56	58.16	58.66	60.12	0.02	11.24	33.49	16.76	1.37
Aiea Stream	308+69	2yr	375	54.64	63.64	71.56	57.13	57.83	59.51	0.04	12.38	30.29	18.68	1.70
Aiea Stream	308+54	2yr	375	53.98	60.90	71.56	55.10	55.92	58.25	0.10	14.23	26.35	28.73	2.62
Aiea Stream	308+42	2yr	375	47.45	60.58	60.48	48.07	49.10	54.04	0.32	19.61	19.12	31.07	4.41
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	2yr	375	45.70	57.64	60.00	49.23	48.13	49.51	0.01	4.21	89.09	33.48	0.45
Aiea Stream	306+46	2yr	375	44.78	57.97	58.00	48.92	47.88	49.26	0.01	4.65	80.87	31.26	0.50
Aiea Stream	306+29	2yr	375	41.50	57.93	62.00	48.90	45.25	49.03	0.00	2.93	128.51	26.42	0.23
Aiea Stream	306+09	2yr	375	45.04	59.90	62.18	48.27	47.67	48.88	0.04	6.27	60.21	24.26	0.68
Aiea Stream	305+79	2yr	375	43.94	58.80	59.99	47.41	46.71	47.95	0.02	5.91	63.84	25.15	0.64
Aiea Stream	305+51	2yr	375	43.74	57.99	61.99	46.56	46.10	47.26	0.05	6.70	56.21	22.99	0.74
Aiea Stream	305+23	2yr	375	42.18	58.00	59.98	44.54	44.48	45.49	0.09	7.80	48.12	23.41	0.95
Aiea Stream	304+92	2yr	375	39.37	58.17	58.09	43.04	42.09	43.56	0.03	5.83	64.83	21.90	0.58
Aiea Stream	304+84	2yr	375	38.00	58.00	58.05	43.00	41.30	43.39	0.01	5.04	75.07	20.92	0.45
Aiea Stream	304+64	2yr	375	38.44	58.02	57.80	42.73	41.36	43.17	0.01	5.36	70.67	21.25	0.50
Aiea Stream	304+44	2yr	375	38.98	48.21	56.10	42.05	41.52	42.74	0.05	6.67	57.07	23.04	0.71
Aiea Stream	304+21	2yr	375	37.88	46.67	54.00	40.54	40.31	41.37	0.08	7.31	51.77	23.99	0.85
Aiea Stream	303+93	2yr	375	36.07	46.36	55.00	38.99	38.89	39.81	0.03	7.28	52.45	28.95	0.91
Aiea Stream	303+59	2yr	375	34.42	44.21	53.95	37.98	37.65	38.79	0.03	7.22	53.77	25.03	0.79
Aiea Stream	303+19	2yr	375	32.80	42.83	50.15	37.29	36.41	37.91	0.02	6.37	59.54	19.45	0.62
Aiea Stream	302+92	2yr	375	31.98	41.74	48.20	36.26	35.81	37.20	0.06	7.79	49.15	17.56	0.78
Aiea Stream	302+50	2yr	375	29.80	40.81	45.50	35.23	33.39	35.62	0.01	5.04	75.99	19.44	0.43
Aiea Stream	302+10	2yr	375	30.40	40.07	43.27	34.62	33.33	35.06	0.02	5.28	71.09	20.55	0.50
Aiea Stream	301+78	2yr	375	29.98	39.79	43.21	34.10	32.51	34.44	0.01	4.67	81.27	23.99	0.43
Aiea Stream	301+49	2yr	375	29.92	36.86	44.19	33.55	32.48	34.01	0.01	5.43	70.80	25.34	0.54
Aiea Stream	301+22	2yr	375	29.85	37.33	44.56	32.81	32.25	33.45	0.04	6.49	59.81	25.05	0.69
Aiea Stream	300+95	2yr	375	28.31	35.42	44.40	31.95	31.21	32.54	0.03	6.23	62.89	24.61	0.64
Aiea Stream	300+68	2yr	375	26.00	34.44	43.24	31.72	29.36	31.95	0.01	3.88	104.24	28.39	0.32
Aiea Stream	300+42	2yr	375	25.80	32.00	42.75	31.57	29.24	31.79	0.01	3.86	106.41	29.31	0.32
Aiea Stream	300+16	2yr	375	26.54	33.39	42.75	31.35	29.18	31.62	0.01	4.31	99.61	28.30	0.35

HEC-RAS Profile Output Table for Shotcrete Wall n=0.03: 5-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	5yr	669	63.94	75.75	75.64	68.38	67.56	69.33	0.02	7.82	87.38	24.56	0.70
Aiea Stream	310+87	5yr	669	63.36	75.59	76.00	67.30	66.91	68.42	0.05	8.47	79.86	26.18	0.83
Aiea Stream	310+57	5yr	669	61.97	74.77	74.51	66.20	65.44	67.14	0.03	7.78	88.24	26.13	0.71
Aiea Stream	310+25	5yr	669	61.02	76.57	78.00	64.80	64.49	65.93	0.05	8.53	79.48	27.32	0.85
Aiea Stream	309+97	5yr	669	60.00	76.05	76.01	64.25	63.27	64.96	0.01	6.79	100.22	30.18	0.63
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	5yr	669	59.00	69.53	71.80	62.21	62.12	63.56	0.05	9.33	71.90	24.67	0.96
Aiea Stream	309+32	5yr	669	57.00	67.00	71.56	61.68	61.04	62.85	0.03	8.74	78.94	20.73	0.73
Aiea Stream	309+08	5yr	669	55.95	68.00	71.56	60.50	60.50	62.31	0.01	10.80	63.68	21.88	0.98
Aiea Stream	308+89	5yr	669	55.45	66.42	71.56	59.21	59.87	61.95	0.02	13.29	52.31	19.15	1.32
Aiea Stream	308+69	5yr	669	54.64	63.64	71.56	57.90	58.94	61.39	0.03	14.99	45.57	20.79	1.70
Aiea Stream	308+54	5yr	669	53.98	60.90	71.56	55.54	56.74	60.14	0.09	17.21	38.88	28.90	2.61
Aiea Stream	308+42	5yr	669	47.45	60.58	60.48	48.41	49.88	56.24	0.24	22.45	29.79	31.07	4.04
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	5yr	669	45.70	57.64	60.00	50.53	48.88	50.93	0.01	5.05	132.98	33.98	0.45
Aiea Stream	306+46	5yr	669	44.78	57.97	58.00	50.26	48.75	50.71	0.01	5.45	123.44	32.61	0.48
Aiea Stream	306+29	5yr	669	41.50	57.93	62.00	50.24	46.37	50.50	0.00	4.11	165.09	28.05	0.29
Aiea Stream	306+09	5yr	669	45.04	59.90	62.18	49.36	48.67	50.30	0.04	7.80	88.07	27.08	0.71
Aiea Stream	305+79	5yr	669	43.94	58.80	59.99	48.55	47.67	49.37	0.02	7.31	93.94	27.81	0.66
Aiea Stream	305+51	5yr	669	43.74	57.99	61.99	47.49	47.11	48.65	0.05	8.64	78.34	24.64	0.81
Aiea Stream	305+23	5yr	669	42.18	58.00	59.98	45.56	45.44	46.89	0.07	9.26	72.69	24.69	0.93
Aiea Stream	304+92	5yr	669	39.37	58.17	58.09	44.33	43.14	45.14	0.03	7.26	94.20	23.69	0.61
Aiea Stream	304+84	5yr	669	38.00	58.00	58.05	44.28	42.49	44.96	0.01	6.65	103.47	23.40	0.52
Aiea Stream	304+64	5yr	669	38.44	58.02	57.80	43.94	42.48	44.70	0.01	7.03	97.79	23.45	0.56
Aiea Stream	304+44	5yr	669	38.98	48.21	56.10	43.15	42.57	44.21	0.05	8.31	84.46	27.42	0.75
Aiea Stream	304+21	5yr	669	37.88	46.67	54.00	41.40	41.31	42.77	0.08	9.43	73.51	26.64	0.93
Aiea Stream	303+93	5yr	669	36.07	46.36	55.00	40.04	39.77	41.11	0.03	8.39	84.59	32.34	0.85
Aiea Stream	303+59	5yr	669	34.42	44.21	53.95	39.33	38.70	40.33	0.02	8.20	88.40	26.47	0.73
Aiea Stream	303+19	5yr	669	32.80	42.83	50.15	38.71	37.54	39.65	0.01	7.82	88.66	21.64	0.64
Aiea Stream	302+92	5yr	669	31.98	41.74	48.20	37.56	37.08	38.97	0.05	9.63	73.59	20.03	0.81
Aiea Stream	302+50	5yr	669	29.80	40.81	45.50	36.64	34.60	37.33	0.01	6.71	103.41	19.47	0.50
Aiea Stream	302+10	5yr	669	30.40	40.07	43.27	35.96	34.36	36.68	0.02	6.81	98.61	20.69	0.55
Aiea Stream	301+78	5yr	669	29.98	39.79	43.21	35.42	33.52	35.98	0.02	6.05	115.04	27.16	0.48
Aiea Stream	301+49	5yr	669	29.92	36.86	44.19	34.81	33.51	35.52	0.01	6.83	104.96	29.09	0.57
Aiea Stream	301+22	5yr	669	29.85	37.33	44.56	34.15	33.27	35.00	0.03	7.54	96.22	29.26	0.66
Aiea Stream	300+95	5yr	669	28.31	35.42	44.40	33.56	32.27	34.28	0.02	6.95	107.46	30.18	0.57
Aiea Stream	300+68	5yr	669	26.00	34.44	43.24	33.44	30.42	33.79	0.01	4.88	153.97	29.71	0.34
Aiea Stream	300+42	5yr	669	25.80	32.00	42.75	33.29	30.28	33.63	0.01	4.79	176.34	57.76	0.34
Aiea Stream	300+16	5yr	669	26.54	33.39	42.75	33.06	30.30	33.46	0.01	5.31	154.95	35.06	0.37

HEC-RAS Profile Output Table for Shotcrete Wall n=0.03: 10-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	10yr	919	63.94	75.75	75.64	69.10	68.28	70.36	0.02	9.04	105.63	25.99	0.74
Aiea Stream	310+87	10yr	919	63.36	75.59	76.00	68.01	67.61	69.42	0.05	9.54	98.84	27.70	0.84
Aiea Stream	310+57	10yr	919	61.97	74.77	74.51	66.85	66.15	68.12	0.03	9.07	105.80	27.61	0.76
Aiea Stream	310+25	10yr	919	61.02	76.57	78.00	65.69	65.16	66.96	0.04	9.09	104.82	29.72	0.80
Aiea Stream	309+97	10yr	919	60.00	76.05	76.01	65.35	63.91	66.13	0.01	7.12	135.25	33.21	0.57
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	10yr	919	59.00	69.53	71.80	63.16	62.80	64.62	0.03	9.70	95.50	25.17	0.86
Aiea Stream	309+32	10yr	919	57.00	67.00	71.56	62.70	61.85	64.07	0.03	9.57	99.95	20.75	0.72
Aiea Stream	309+08	10yr	919	55.95	68.00	71.56	61.39	61.39	63.57	0.01	11.90	83.50	22.82	0.97
Aiea Stream	308+89	10yr	919	55.45	66.42	71.56	60.05	60.84	63.23	0.02	14.36	69.06	21.05	1.27
Aiea Stream	308+69	10yr	919	54.64	63.64	71.56	58.50	59.75	62.69	0.03	16.47	58.49	22.44	1.67
Aiea Stream	308+54	10yr	919	53.98	60.90	71.56	55.87	57.34	61.45	0.08	18.96	48.51	29.02	2.58
Aiea Stream	308+42	10yr	919	47.45	60.58	60.48	48.68	50.45	57.70	0.20	24.10	38.13	31.07	3.83
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	10yr	919	45.70	57.64	60.00	51.46	49.42	51.95	0.01	5.61	164.78	34.34	0.45
Aiea Stream	306+46	10yr	919	44.78	57.97	58.00	51.19	49.34	51.75	0.01	5.99	154.23	33.18	0.48
Aiea Stream	306+29	10yr	919	41.50	57.93	62.00	51.17	47.17	51.54	0.00	4.90	191.71	29.18	0.32
Aiea Stream	306+09	10yr	919	45.04	59.90	62.18	50.14	49.39	51.30	0.04	8.71	109.89	29.04	0.72
Aiea Stream	305+79	10yr	919	43.94	58.80	59.99	49.38	48.37	50.39	0.01	8.12	118.08	29.99	0.66
Aiea Stream	305+51	10yr	919	43.74	57.99	61.99	48.10	47.84	49.65	0.05	9.98	93.62	25.96	0.87
Aiea Stream	305+23	10yr	919	42.18	58.00	59.98	46.30	46.14	47.90	0.07	10.18	91.11	25.60	0.92
Aiea Stream	304+92	10yr	919	39.37	58.17	58.09	45.18	43.91	46.22	0.03	8.25	114.97	24.87	0.63
Aiea Stream	304+84	10yr	919	38.00	58.00	58.05	45.13	43.32	46.04	0.01	7.73	123.99	25.04	0.55
Aiea Stream	304+64	10yr	919	38.44	58.02	57.80	44.74	43.31	45.75	0.01	8.16	117.02	24.89	0.61
Aiea Stream	304+44	10yr	919	38.98	48.21	56.10	43.92	43.34	45.23	0.05	9.33	106.89	31.22	0.77
Aiea Stream	304+21	10yr	919	37.88	46.67	54.00	42.04	42.03	43.78	0.08	10.67	91.33	28.55	0.96
Aiea Stream	303+93	10yr	919	36.07	46.36	55.00	40.93	40.41	42.10	0.02	8.78	114.39	34.11	0.78
Aiea Stream	303+59	10yr	919	34.42	44.21	53.95	40.34	39.41	41.48	0.02	8.78	116.12	27.90	0.70
Aiea Stream	303+19	10yr	919	32.80	42.83	50.15	39.72	38.37	40.89	0.01	8.76	111.43	23.59	0.65
Aiea Stream	302+92	10yr	919	31.98	41.74	48.20	38.47	37.99	40.21	0.05	10.78	92.68	21.85	0.82
Aiea Stream	302+50	10yr	919	29.80	40.81	45.50	37.60	35.43	38.55	0.01	7.87	122.03	19.49	0.54
Aiea Stream	302+10	10yr	919	30.40	40.07	43.27	36.88	35.12	37.83	0.02	7.85	117.69	20.78	0.58
Aiea Stream	301+78	10yr	919	29.98	39.79	43.21	36.36	34.27	37.08	0.02	6.89	142.19	31.32	0.50
Aiea Stream	301+49	10yr	919	29.92	36.86	44.19	35.74	34.25	36.62	0.01	7.64	133.35	37.60	0.58
Aiea Stream	301+22	10yr	919	29.85	37.33	44.56	35.22	34.01	36.14	0.03	7.97	129.56	32.93	0.62
Aiea Stream	300+95	10yr	919	28.31	35.42	44.40	34.75	33.04	35.54	0.02	7.35	144.73	32.42	0.54
Aiea Stream	300+68	10yr	919	26.00	34.44	43.24	34.64	31.20	35.12	0.01	5.66	194.64	63.56	0.37
Aiea Stream	300+42	10yr	919	25.80	32.00	42.75	34.58	31.02	34.92	0.01	5.07	267.88	84.22	0.33
Aiea Stream	300+16	10yr	919	26.54	33.39	42.75	34.27	31.09	34.76	0.01	5.98	205.54	53.13	0.38

HEC-RAS Profile Output Table for Shotcrete Wall n=0.03: 25-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	25yr	1916	63.94	75.75	75.64	71.30	70.71	73.70	0.02	12.58	167.56	30.35	0.85
Aiea Stream	310+87	25yr	1916	63.36	75.59	76.00	70.45	69.87	72.67	0.04	12.09	173.64	33.46	0.84
Aiea Stream	310+57	25yr	1916	61.97	74.77	74.51	69.54	68.49	71.54	0.03	11.50	188.33	33.81	0.76
Aiea Stream	310+25	25yr	1916	61.02	76.57	78.00	69.18	67.38	70.60	0.02	9.76	225.55	39.43	0.63
Aiea Stream	309+97	25yr	1916	60.00	76.05	76.01	69.16	66.03	70.10	0.00	7.96	281.71	43.58	0.48
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	25yr	1916	59.00	69.53	71.80	67.06	65.05	68.61	0.01	10.06	197.64	27.22	0.63
Aiea Stream	309+32	25yr	1916	57.00	67.00	71.56	65.96	64.36	68.13	0.02	12.14	167.78	20.79	0.73
Aiea Stream	309+08	25yr	1916	55.95	68.00	71.56	64.13	64.13	67.63	0.01	15.28	150.03	25.75	0.99
Aiea Stream	308+89	25yr	1916	55.45	66.42	71.56	62.53	63.58	67.31	0.01	17.85	134.60	28.53	1.24
Aiea Stream	308+69	25yr	1916	54.64	63.64	71.56	60.51	62.38	66.82	0.02	20.31	110.53	31.02	1.60
Aiea Stream	308+54	25yr	1916	53.98	60.90	71.56	57.02	59.33	65.53	0.06	23.41	82.31	29.44	2.45
Aiea Stream	308+42	25yr	1916	47.45	60.58	60.48	49.63	52.35	62.01	0.14	28.23	67.86	31.08	3.37
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	25yr	1916	45.70	57.64	60.00	54.37	51.25	55.18	0.01	7.27	266.26	35.44	0.46
Aiea Stream	306+46	25yr	1916	44.78	57.97	58.00	54.08	51.24	54.98	0.01	7.64	252.55	34.95	0.48
Aiea Stream	306+29	25yr	1916	41.50	57.93	62.00	54.01	49.48	54.80	0.01	7.22	277.55	31.22	0.40
Aiea Stream	306+09	25yr	1916	45.04	59.90	62.18	52.68	51.66	54.49	0.03	10.78	191.62	35.11	0.72
Aiea Stream	305+79	25yr	1916	43.94	58.80	59.99	52.17	50.62	53.65	0.01	9.98	212.10	37.37	0.64
Aiea Stream	305+51	25yr	1916	43.74	57.99	61.99	50.17	50.17	52.87	0.05	13.04	152.48	31.28	0.92
Aiea Stream	305+23	25yr	1916	42.18	58.00	59.98	48.57	48.41	51.12	0.06	12.81	152.98	29.50	0.91
Aiea Stream	304+92	25yr	1916	39.37	58.17	58.09	47.58	46.38	49.51	0.03	11.35	178.41	28.15	0.72
Aiea Stream	304+84	25yr	1916	38.00	58.00	58.05	47.49	45.96	49.30	0.02	10.94	188.57	29.62	0.67
Aiea Stream	304+64	25yr	1916	38.44	58.02	57.80	46.78	45.87	48.90	0.02	11.89	172.73	30.36	0.76
Aiea Stream	304+44	25yr	1916	38.98	48.21	56.10	45.89	45.76	48.24	0.05	12.76	177.28	39.98	0.88
Aiea Stream	304+21	25yr	1916	37.88	46.67	54.00	44.64	44.36	46.95	0.06	12.57	175.39	36.29	0.88
Aiea Stream	303+93	25yr	1916	36.07	46.36	55.00	44.25	42.44	45.60	0.01	9.57	236.68	39.50	0.63
Aiea Stream	303+59	25yr	1916	34.42	44.21	53.95	43.62	41.73	45.20	0.01	10.54	212.67	31.24	0.65
Aiea Stream	303+19	25yr	1916	32.80	42.83	50.15	42.78	41.10	44.69	0.01	11.39	193.24	29.87	0.68
Aiea Stream	302+92	25yr	1916	31.98	41.74	48.20	41.28	40.88	44.02	0.05	13.86	162.14	27.71	0.86
Aiea Stream	302+50	25yr	1916	29.80	40.81	45.50	40.28	38.11	42.35	0.02	11.63	174.38	19.54	0.67
Aiea Stream	302+10	25yr	1916	30.40	40.07	43.27	39.33	37.63	41.37	0.03	11.45	169.14	21.69	0.71
Aiea Stream	301+78	25yr	1916	29.98	39.79	43.21	38.93	36.74	40.24	0.02	9.51	231.68	74.02	0.57
Aiea Stream	301+49	25yr	1916	29.92	36.86	44.19	38.60	36.61	39.74	0.01	9.22	326.40	135.18	0.57
Aiea Stream	301+22	25yr	1916	29.85	37.33	44.56	37.86	36.23	39.30	0.02	10.24	255.30	124.46	0.65
Aiea Stream	300+95	25yr	1916	28.31	35.42	44.40	37.65	35.30	38.62	0.01	8.75	338.83	128.17	0.52
Aiea Stream	300+68	25yr	1916	26.00	34.44	43.24	37.62	33.47	38.21	0.01	6.91	432.58	142.64	0.38
Aiea Stream	300+42	25yr	1916	25.80	32.00	42.75	37.60	33.76	38.01	0.00	6.04	523.00	142.19	0.33
Aiea Stream	300+16	25yr	1916	26.54	33.39	42.75	37.21	33.30	37.85	0.01	7.44	431.45	111.80	0.41

HEC-RAS Profile Output Table for Shotcrete Wall n=0.03: 50-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	50yr	2321	63.94	75.75	75.64	72.13	71.55	74.88	0.02	13.49	193.41	32.00	0.86
Aiea Stream	310+87	50yr	2321	63.36	75.59	76.00	71.48	70.66	73.84	0.04	12.50	209.10	35.32	0.81
Aiea Stream	310+57	50yr	2321	61.97	74.77	74.51	70.76	69.30	72.83	0.02	11.77	231.34	36.86	0.72
Aiea Stream	310+25	50yr	2321	61.02	76.57	78.00	70.60	68.15	71.99	0.02	9.77	284.29	43.37	0.58
Aiea Stream	309+97	50yr	2321	60.00	76.05	76.01	70.62	66.76	71.58	0.00	8.12	347.71	47.13	0.45
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	50yr	2321	59.00	69.53	71.80	68.45	65.83	70.08	0.01	10.30	236.22	27.96	0.60
Aiea Stream	309+32	50yr	2321	57.00	67.00	71.56	67.10	65.26	69.57	0.02	12.97	192.75	26.99	0.73
Aiea Stream	309+08	50yr	2321	55.95	68.00	71.56	65.07	65.07	69.06	0.01	16.34	174.77	26.76	1.00
Aiea Stream	308+89	50yr	2321	55.45	66.42	71.56	63.36	64.51	68.73	0.01	19.01	158.60	29.57	1.24
Aiea Stream	308+69	50yr	2321	54.64	63.64	71.56	61.16	63.24	68.23	0.02	21.60	131.10	32.21	1.60
Aiea Stream	308+54	50yr	2321	53.98	60.90	71.56	57.44	60.04	66.92	0.06	24.72	94.61	29.60	2.42
Aiea Stream	308+42	50yr	2321	47.45	60.58	60.48	49.99	53.02	63.44	0.12	29.43	78.85	31.08	3.26
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	50yr	2321	45.70	57.64	60.00	55.33	51.89	56.27	0.01	7.82	300.35	35.82	0.46
Aiea Stream	306+46	50yr	2321	44.78	57.97	58.00	55.02	51.90	56.06	0.01	8.19	285.83	35.55	0.49
Aiea Stream	306+29	50yr	2321	41.50	57.93	62.00	54.93	50.28	55.89	0.01	7.96	306.55	31.85	0.42
Aiea Stream	306+09	50yr	2321	45.04	59.90	62.18	53.55	52.41	55.56	0.03	11.33	222.92	37.22	0.71
Aiea Stream	305+79	50yr	2321	43.94	58.80	59.99	53.10	51.37	54.74	0.01	10.51	248.22	39.79	0.64
Aiea Stream	305+51	50yr	2321	43.74	57.99	61.99	50.97	50.97	53.96	0.05	13.62	178.83	34.03	0.91
Aiea Stream	305+23	50yr	2321	42.18	58.00	59.98	48.96	49.21	52.22	0.07	14.46	164.79	30.48	1.00
Aiea Stream	304+92	50yr	2321	39.37	58.17	58.09	48.33	47.21	50.61	0.03	12.33	200.16	29.21	0.75
Aiea Stream	304+84	50yr	2321	38.00	58.00	58.05	48.24	46.84	50.39	0.02	11.93	211.37	31.08	0.69
Aiea Stream	304+64	50yr	2321	38.44	58.02	57.80	47.29	46.79	49.94	0.02	13.32	188.50	32.04	0.82
Aiea Stream	304+44	50yr	2321	38.98	48.21	56.10	46.67	46.50	49.23	0.05	13.41	209.95	42.79	0.87
Aiea Stream	304+21	50yr	2321	37.88	46.67	54.00	45.60	45.13	48.01	0.05	12.96	211.69	39.54	0.84
Aiea Stream	303+93	50yr	2321	36.07	46.36	55.00	45.31	43.15	46.78	0.01	10.03	279.43	41.21	0.61
Aiea Stream	303+59	50yr	2321	34.42	44.21	53.95	44.61	42.53	46.40	0.01	11.27	251.29	54.76	0.65
Aiea Stream	303+19	50yr	2321	32.80	42.83	50.15	43.78	42.05	45.89	0.01	12.11	237.68	67.68	0.68
Aiea Stream	302+92	50yr	2321	31.98	41.74	48.20	42.21	42.21	45.23	0.05	14.68	195.80	54.18	0.86
Aiea Stream	302+50	50yr	2321	29.80	40.81	45.50	41.00	39.07	43.62	0.02	13.07	190.23	33.25	0.73
Aiea Stream	302+10	50yr	2321	30.40	40.07	43.27	39.86	38.51	42.50	0.04	13.03	180.97	40.42	0.78
Aiea Stream	301+78	50yr	2321	29.98	39.79	43.21	39.46	37.57	41.11	0.02	10.72	252.24	99.92	0.63
Aiea Stream	301+49	50yr	2321	29.92	36.86	44.19	39.18	38.07	40.47	0.01	10.01	380.75	154.58	0.59
Aiea Stream	301+22	50yr	2321	29.85	37.33	44.56	38.75	37.00	40.07	0.02	10.16	339.48	153.64	0.61
Aiea Stream	300+95	50yr	2321	28.31	35.42	44.40	38.53	37.01	39.49	0.01	8.97	413.61	158.56	0.51
Aiea Stream	300+68	50yr	2321	26.00	34.44	43.24	38.48	34.25	39.12	0.01	7.35	503.11	165.25	0.39
Aiea Stream	300+42	50yr	2321	25.80	32.00	42.75	38.46	34.79	38.92	0.00	6.48	595.15	158.58	0.34
Aiea Stream	300+16	50yr	2321	26.54	33.39	42.75	38.07	34.72	38.75	0.01	7.84	506.07	129.07	0.41

HEC-RAS Profile Output Table for Shotcrete Wall n=0.03: 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	100yr	2743	63.94	75.75	75.64	73.04	72.36	76.03	0.02	14.13	223.43	33.96	0.85
Aiea Stream	310+87	100yr	2743	63.36	75.59	76.00	72.62	71.40	75.02	0.03	12.69	250.35	37.28	0.76
Aiea Stream	310+57	100yr	2743	61.97	74.77	74.51	72.06	70.05	74.14	0.02	11.88	280.79	39.37	0.68
Aiea Stream	310+25	100yr	2743	61.02	76.57	78.00	72.04	68.88	73.40	0.01	9.75	349.43	47.33	0.53
Aiea Stream	309+97	100yr	2743	60.00	76.05	76.01	72.07	67.48	73.05	0.00	8.25	418.78	50.75	0.43
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	100yr	2743	59.00	69.53	71.80	69.78	66.59	71.51	0.01	10.62	273.86	29.49	0.58
Aiea Stream	309+32	100yr	2743	57.00	67.00	71.56	68.28	66.13	70.98	0.02	13.61	225.73	31.07	0.72
Aiea Stream	309+08	100yr	2743	55.95	68.00	71.56	66.01	66.01	70.46	0.01	17.31	200.24	27.77	1.00
Aiea Stream	308+89	100yr	2743	55.45	66.42	71.56	64.17	65.44	70.12	0.01	20.09	182.90	30.58	1.24
Aiea Stream	308+69	100yr	2743	54.64	63.64	71.56	61.79	64.12	69.62	0.02	22.82	151.71	33.36	1.60
Aiea Stream	308+54	100yr	2743	53.98	60.90	71.56	57.85	60.72	68.28	0.05	25.93	106.80	29.75	2.39
Aiea Stream	308+42	100yr	2743	47.45	60.58	60.48	50.34	53.68	64.83	0.12	30.54	89.81	31.08	3.17
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	100yr	2743	45.70	57.64	60.00	56.24	52.51	57.30	0.01	8.34	333.02	36.31	0.47
Aiea Stream	306+46	100yr	2743	44.78	57.97	58.00	55.92	52.52	57.09	0.01	8.72	317.86	36.12	0.49
Aiea Stream	306+29	100yr	2743	41.50	57.93	62.00	55.79	51.05	56.93	0.01	8.67	334.42	32.43	0.44
Aiea Stream	306+09	100yr	2743	45.04	59.90	62.18	54.38	53.16	56.59	0.03	11.82	254.72	39.30	0.70
Aiea Stream	305+79	100yr	2743	43.94	58.80	59.99	54.00	52.12	55.78	0.01	10.99	284.90	42.11	0.64
Aiea Stream	305+51	100yr	2743	43.74	57.99	61.99	51.75	51.75	55.00	0.05	14.12	206.25	36.47	0.89
Aiea Stream	305+23	100yr	2743	42.18	58.00	59.98	49.60	49.97	53.28	0.07	15.33	184.87	32.06	1.01
Aiea Stream	304+92	100yr	2743	39.37	58.17	58.09	49.08	48.03	51.68	0.03	13.20	222.38	30.26	0.77
Aiea Stream	304+84	100yr	2743	38.00	58.00	58.05	48.98	47.69	51.46	0.02	12.78	235.04	32.58	0.72
Aiea Stream	304+64	100yr	2743	38.44	58.02	57.80	47.92	47.63	50.98	0.03	14.36	209.32	34.13	0.85
Aiea Stream	304+44	100yr	2743	38.98	48.21	56.10	47.42	47.26	50.17	0.05	14.03	242.68	45.38	0.87
Aiea Stream	304+21	100yr	2743	37.88	46.67	54.00	46.39	45.89	49.00	0.05	13.54	244.46	42.40	0.84
Aiea Stream	303+93	100yr	2743	36.07	46.36	55.00	46.15	43.83	47.80	0.01	10.70	314.26	42.56	0.62
Aiea Stream	303+59	100yr	2743	34.42	44.21	53.95	45.40	43.32	47.41	0.01	12.05	292.20	80.53	0.67
Aiea Stream	303+19	100yr	2743	32.80	42.83	50.15	44.47	43.10	46.88	0.01	13.07	272.63	93.40	0.71
Aiea Stream	302+92	100yr	2743	31.98	41.74	48.20	43.20	43.18	46.23	0.04	15.01	243.13	87.93	0.83
Aiea Stream	302+50	100yr	2743	29.80	40.81	45.50	41.87	40.02	44.86	0.02	14.05	230.48	66.91	0.75
Aiea Stream	302+10	100yr	2743	30.40	40.07	43.27	40.40	39.39	43.62	0.04	14.44	203.47	74.10	0.84
Aiea Stream	301+78	100yr	2743	29.98	39.79	43.21	40.05	38.33	42.00	0.02	11.73	287.80	130.71	0.67
Aiea Stream	301+49	100yr	2743	29.92	36.86	44.19	39.89	38.70	41.23	0.01	10.41	448.17	177.27	0.59
Aiea Stream	301+22	100yr	2743	29.85	37.33	44.56	39.61	37.15	40.82	0.02	10.08	420.15	181.55	0.58
Aiea Stream	300+95	100yr	2743	28.31	35.42	44.40	39.36	37.54	40.33	0.01	9.21	484.40	187.32	0.50
Aiea Stream	300+68	100yr	2743	26.00	34.44	43.24	39.29	34.18	39.98	0.01	7.76	570.19	186.74	0.39
Aiea Stream	300+42	100yr	2743	25.80	32.00	42.75	39.27	35.36	39.78	0.00	6.90	663.71	174.16	0.35
Aiea Stream	300+16	100yr	2743	26.54	33.39	42.75	38.89	35.69	39.61	0.01	8.22	577.01	145.48	0.42

HEC-RAS Profile Output Table for Shotcrete Wall n=0.03: USACE 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	USACE100yr	3850	63.94	75.75	75.64	77.04	74.31	79.48	0.01	13.00	377.33	41.28	0.65
Aiea Stream	310+87	USACE100yr	3850	63.36	75.59	76.00	77.06	73.18	78.89	0.01	11.29	432.41	43.17	0.55
Aiea Stream	310+57	USACE100yr	3850	61.97	74.77	74.51	76.85	71.96	78.47	0.01	10.67	487.07	44.43	0.50
Aiea Stream	310+25	USACE100yr	3850	61.02	76.57	78.00	77.04	70.62	78.04	0.01	8.62	620.47	60.98	0.39
Aiea Stream	309+97	USACE100yr	3850	60.00	76.05	76.01	77.06	69.17	77.87	0.00	7.66	699.60	59.56	0.33
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	USACE100yr	3850	59.00	69.53	71.80	72.80	68.46	74.75	0.01	11.38	381.88	43.86	0.54
Aiea Stream	309+32	USACE100yr	3850	57.00	67.00	71.56	71.80	68.78	74.38	0.01	13.67	361.97	40.56	0.63
Aiea Stream	309+08	USACE100yr	3850	55.95	68.00	71.56	68.38	68.38	73.83	0.01	19.22	274.23	36.22	0.99
Aiea Stream	308+89	USACE100yr	3850	55.45	66.42	71.56	66.11	67.69	73.47	0.01	22.46	244.60	33.19	1.25
Aiea Stream	308+69	USACE100yr	3850	54.64	63.64	71.56	63.28	66.07	72.94	0.02	25.52	203.81	36.51	1.61
Aiea Stream	308+54	USACE100yr	3850	53.98	60.90	71.56	58.85	62.45	71.53	0.05	28.61	136.55	30.11	2.34
Aiea Stream	308+42	USACE100yr	3850	47.45	60.58	60.48	51.20	55.26	68.12	0.10	33.01	116.63	31.08	3.00
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	USACE100yr	3850	45.70	57.64	60.00	58.36	54.01	59.74	0.01	9.52	413.76	42.29	0.49
Aiea Stream	306+46	USACE100yr	3850	44.78	57.97	58.00	58.02	54.08	59.53	0.01	9.88	395.31	38.15	0.51
Aiea Stream	306+29	USACE100yr	3850	41.50	57.93	62.00	57.76	52.86	59.36	0.01	10.27	399.55	33.77	0.49
Aiea Stream	306+09	USACE100yr	3850	45.04	59.90	62.18	56.32	54.87	58.99	0.03	12.84	336.21	45.40	0.69
Aiea Stream	305+79	USACE100yr	3850	43.94	58.80	59.99	56.08	53.81	58.19	0.01	12.02	379.65	49.11	0.63
Aiea Stream	305+51	USACE100yr	3850	43.74	57.99	61.99	53.54	53.54	57.40	0.04	15.16	276.41	41.82	0.86
Aiea Stream	305+23	USACE100yr	3850	42.18	58.00	59.98	51.15	51.79	55.75	0.06	17.05	237.62	36.06	1.02
Aiea Stream	304+92	USACE100yr	3850	39.37	58.17	58.09	50.48	49.87	54.12	0.04	15.67	266.06	32.55	0.85
Aiea Stream	304+84	USACE100yr	3850	38.00	58.00	58.05	50.36	49.64	53.86	0.02	15.18	283.66	37.71	0.80
Aiea Stream	304+64	USACE100yr	3850	38.44	58.02	57.80	49.59	49.59	53.37	0.03	16.07	270.84	39.66	0.88
Aiea Stream	304+44	USACE100yr	3850	38.98	48.21	56.10	48.22	49.06	52.36	0.07	17.34	280.49	49.85	1.03
Aiea Stream	304+21	USACE100yr	3850	37.88	46.67	54.00	48.28	48.14	51.07	0.04	14.40	352.69	77.05	0.80
Aiea Stream	303+93	USACE100yr	3850	36.07	46.36	55.00	47.93	45.47	50.10	0.01	12.37	416.00	76.71	0.66
Aiea Stream	303+59	USACE100yr	3850	34.42	44.21	53.95	47.17	45.62	49.70	0.01	13.78	386.41	138.97	0.71
Aiea Stream	303+19	USACE100yr	3850	32.80	42.83	50.15	45.82	45.41	49.08	0.02	15.51	344.01	143.88	0.80
Aiea Stream	302+92	USACE100yr	3850	31.98	41.74	48.20	45.21	44.97	48.41	0.04	16.03	345.59	156.82	0.81
Aiea Stream	302+50	USACE100yr	3850	29.80	40.81	45.50	43.78	43.78	47.14	0.02	15.46	349.40	157.27	0.76
Aiea Stream	302+10	USACE100yr	3850	30.40	40.07	43.27	42.47	42.47	45.94	0.04	15.48	314.39	168.07	0.81
Aiea Stream	301+78	USACE100yr	3850	29.98	39.79	43.21	41.78	41.08	43.80	0.02	12.50	440.66	211.46	0.65
Aiea Stream	301+49	USACE100yr	3850	29.92	36.86	44.19	41.67	39.97	43.08	0.01	11.13	616.62	230.67	0.58
Aiea Stream	301+22	USACE100yr	3850	29.85	37.33	44.56	41.57	39.75	42.66	0.01	10.09	606.71	237.53	0.52
Aiea Stream	300+95	USACE100yr	3850	28.31	35.42	44.40	41.29	38.70	42.31	0.01	9.82	648.44	241.77	0.49
Aiea Stream	300+68	USACE100yr	3850	26.00	34.44	43.24	41.19	37.38	42.00	0.01	8.67	726.53	227.20	0.41
Aiea Stream	300+42	USACE100yr	3850	25.80	32.00	42.75	41.17	36.50	41.79	0.01	7.83	823.45	209.00	0.37
Aiea Stream	300+16	USACE100yr	3850	26.54	33.39	42.75	40.81	37.27	41.62	0.01	9.06	742.38	183.74	0.43

APPENDIX 18

HEC-RAS Model Results Table for Proposed Condition n=0.05

HEC-RAS Profile Output Table for Shotcrete Wall n=0.05: 2-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	2yr	375	63.94	75.75	75.64	67.32	66.56	67.89	0.017052	6.03	62.50	22.71	0.63
Aiea Stream	310+87	2yr	375	63.36	75.59	76.00	66.30	65.95	67.03	0.055448	6.87	54.59	23.97	0.80
Aiea Stream	310+57	2yr	375	61.97	74.77	74.51	65.19	64.45	65.75	0.026003	5.98	63.04	23.97	0.64
Aiea Stream	310+25	2yr	375	61.02	76.57	78.00	63.71	63.54	64.54	0.064930	7.34	51.11	24.33	0.89
Aiea Stream	309+97	2yr	375	60.00	76.05	76.01	62.69	62.34	63.37	0.015021	6.61	56.76	25.89	0.79
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	2yr	375	59.00	69.53	71.80	61.20	61.20	62.18	0.057120	7.95	47.19	24.13	1.00
Aiea Stream	309+32	2yr	375	57.00	67.00	71.56	60.28	59.74	61.13	0.033701	7.38	50.82	16.88	0.75
Aiea Stream	309+08	2yr	375	55.95	68.00	71.56	59.24	59.24	60.52	0.012042	9.08	41.29	16.32	1.01
Aiea Stream	308+89	2yr	375	55.45	66.42	71.56	58.16	58.66	60.12	0.022461	11.24	33.49	16.76	1.37
Aiea Stream	308+69	2yr	375	54.64	63.64	71.56	57.13	57.83	59.51	0.036132	12.38	30.29	18.68	1.70
Aiea Stream	308+54	2yr	375	53.98	60.90	71.56	55.10	55.92	58.25	0.098108	14.23	26.35	28.73	2.62
Aiea Stream	308+42	2yr	375	47.45	60.58	60.48	48.07	49.10	54.04	0.315347	19.61	19.12	31.07	4.41
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	2yr	375	45.70	57.64	60.00	49.23	48.13	49.51	0.012254	4.21	89.19	33.48	0.45
Aiea Stream	306+46	2yr	375	44.78	57.97	58.00	48.93	47.88	49.26	0.014510	4.65	80.92	31.26	0.50
Aiea Stream	306+29	2yr	375	41.50	57.93	62.00	48.90	45.25	49.03	0.002705	2.93	128.56	26.42	0.23
Aiea Stream	306+09	2yr	375	45.04	59.90	62.18	48.28	47.67	48.89	0.042777	6.27	60.25	24.26	0.68
Aiea Stream	305+79	2yr	375	43.94	58.80	59.99	47.41	46.71	47.95	0.016447	5.91	63.91	25.16	0.64
Aiea Stream	305+51	2yr	375	43.74	57.99	61.99	46.57	46.10	47.26	0.045784	6.71	56.22	22.99	0.74
Aiea Stream	305+23	2yr	375	42.18	58.00	59.98	44.54	44.48	45.49	0.086829	7.79	48.14	23.41	0.95
Aiea Stream	304+92	2yr	375	39.37	58.17	58.09	43.04	42.09	43.57	0.027158	5.84	64.84	21.90	0.58
Aiea Stream	304+84	2yr	375	38.00	58.00	58.05	43.00	41.30	43.39	0.009459	5.05	75.07	20.92	0.45
Aiea Stream	304+64	2yr	375	38.44	58.02	57.80	42.73	41.36	43.17	0.011622	5.37	70.65	21.25	0.50
Aiea Stream	304+44	2yr	375	38.98	48.21	56.10	42.05	41.52	42.74	0.047782	6.67	57.07	23.04	0.71
Aiea Stream	304+21	2yr	375	37.88	46.67	54.00	40.54	40.31	41.37	0.077400	7.31	51.77	23.99	0.85
Aiea Stream	303+93	2yr	375	36.07	46.36	55.00	38.99	38.89	39.81	0.033519	7.28	52.45	28.95	0.91
Aiea Stream	303+59	2yr	375	34.42	44.21	53.95	37.98	37.65	38.79	0.026077	7.22	53.77	25.03	0.79
Aiea Stream	303+19	2yr	375	32.80	42.83	50.15	37.29	36.41	37.91	0.015745	6.37	59.54	19.45	0.62
Aiea Stream	302+92	2yr	375	31.98	41.74	48.20	36.26	35.81	37.20	0.055468	7.79	49.15	17.56	0.78
Aiea Stream	302+50	2yr	375	29.80	40.81	45.50	35.23	33.39	35.62	0.010159	5.04	75.99	19.44	0.43
Aiea Stream	302+10	2yr	375	30.40	40.07	43.27	34.62	33.33	35.06	0.021706	5.28	71.09	20.55	0.50
Aiea Stream	301+78	2yr	375	29.98	39.79	43.21	34.10	32.51	34.44	0.014238	4.67	81.27	23.99	0.43
Aiea Stream	301+49	2yr	375	29.92	36.86	44.19	33.55	32.48	34.01	0.013594	5.43	70.80	25.34	0.54
Aiea Stream	301+22	2yr	375	29.85	37.33	44.56	32.81	32.25	33.45	0.038625	6.49	59.81	25.05	0.69
Aiea Stream	300+95	2yr	375	28.31	35.42	44.40	31.95	31.21	32.54	0.027150	6.23	62.89	24.61	0.64
Aiea Stream	300+68	2yr	375	26.00	34.44	43.24	31.72	29.36	31.95	0.006068	3.88	104.24	28.39	0.32
Aiea Stream	300+42	2yr	375	25.80	32.00	42.75	31.57	29.24	31.79	0.005867	3.86	106.41	29.31	0.32
Aiea Stream	300+16	2yr	375	26.54	33.39	42.75	31.35	29.18	31.62	0.007004	4.31	99.61	28.30	0.35

HEC-RAS Profile Output Table for Shotcrete Wall n=0.05: 5-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	5yr	669	63.94	75.75	75.64	68.38	67.56	69.33	0.018890	7.82	87.38	24.56	0.70
Aiea Stream	310+87	5yr	669	63.36	75.59	76.00	67.30	66.91	68.42	0.052319	8.47	79.86	26.18	0.83
Aiea Stream	310+57	5yr	669	61.97	74.77	74.51	66.20	65.44	67.14	0.029054	7.78	88.24	26.13	0.71
Aiea Stream	310+25	5yr	669	61.02	76.57	78.00	64.80	64.49	65.93	0.052222	8.53	79.48	27.32	0.85
Aiea Stream	309+97	5yr	669	60.00	76.05	76.01	64.25	63.27	64.96	0.008090	6.79	100.22	30.18	0.63
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	5yr	669	59.00	69.53	71.80	62.21	62.12	63.56	0.045510	9.33	71.90	24.67	0.96
Aiea Stream	309+32	5yr	669	57.00	67.00	71.56	61.68	61.04	62.85	0.028442	8.74	78.94	20.73	0.73
Aiea Stream	309+08	5yr	669	55.95	68.00	71.56	60.50	60.50	62.31	0.009937	10.80	63.68	21.88	0.98
Aiea Stream	308+89	5yr	669	55.45	66.42	71.56	59.21	59.87	61.95	0.018254	13.29	52.31	19.15	1.32
Aiea Stream	308+69	5yr	669	54.64	63.64	71.56	57.90	58.94	61.39	0.031608	14.99	45.57	20.79	1.70
Aiea Stream	308+54	5yr	669	53.98	60.90	71.56	55.54	56.74	60.14	0.087261	17.21	38.88	28.90	2.61
Aiea Stream	308+42	5yr	669	47.45	60.58	60.48	48.41	49.88	56.24	0.235393	22.45	29.79	31.07	4.04
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	5yr	669	45.70	57.64	60.00	50.55	48.88	50.94	0.010301	5.04	133.58	33.99	0.44
Aiea Stream	306+46	5yr	669	44.78	57.97	58.00	50.27	48.75	50.73	0.011639	5.47	123.81	32.62	0.48
Aiea Stream	306+29	5yr	669	41.50	57.93	62.00	50.25	46.37	50.51	0.003880	4.11	165.44	28.07	0.29
Aiea Stream	306+09	5yr	669	45.04	59.90	62.18	49.37	48.67	50.31	0.041877	7.81	88.41	27.11	0.71
Aiea Stream	305+79	5yr	669	43.94	58.80	59.99	48.56	47.66	49.38	0.015701	7.32	94.25	27.84	0.66
Aiea Stream	305+51	5yr	669	43.74	57.99	61.99	47.50	47.11	48.66	0.050796	8.69	78.49	24.65	0.82
Aiea Stream	305+23	5yr	669	42.18	58.00	59.98	45.57	45.44	46.90	0.073710	9.26	72.83	24.69	0.93
Aiea Stream	304+92	5yr	669	39.37	58.17	58.09	44.33	43.14	45.14	0.026789	7.29	94.25	23.69	0.61
Aiea Stream	304+84	5yr	669	38.00	58.00	58.05	44.28	42.48	44.97	0.011443	6.71	103.41	23.39	0.52
Aiea Stream	304+64	5yr	669	38.44	58.02	57.80	43.93	42.48	44.70	0.013804	7.09	97.57	23.43	0.57
Aiea Stream	304+44	5yr	669	38.98	48.21	56.10	43.15	42.57	44.21	0.047208	8.31	84.46	27.42	0.75
Aiea Stream	304+21	5yr	669	37.88	46.67	54.00	41.40	41.31	42.77	0.084611	9.43	73.51	26.64	0.93
Aiea Stream	303+93	5yr	669	36.07	46.36	55.00	40.04	39.77	41.11	0.025272	8.39	84.59	32.34	0.85
Aiea Stream	303+59	5yr	669	34.42	44.21	53.95	39.33	38.70	40.33	0.019236	8.20	88.40	26.47	0.73
Aiea Stream	303+19	5yr	669	32.80	42.83	50.15	38.71	37.54	39.65	0.014610	7.82	88.66	21.64	0.64
Aiea Stream	302+92	5yr	669	31.98	41.74	48.20	37.56	37.08	38.97	0.053036	9.63	73.59	20.03	0.81
Aiea Stream	302+50	5yr	669	29.80	40.81	45.50	36.64	34.60	37.33	0.012241	6.71	103.41	19.47	0.50
Aiea Stream	302+10	5yr	669	30.40	40.07	43.27	35.96	34.36	36.68	0.023407	6.81	98.61	20.69	0.55
Aiea Stream	301+78	5yr	669	29.98	39.79	43.21	35.42	33.52	35.98	0.015821	6.05	115.04	27.16	0.48
Aiea Stream	301+49	5yr	669	29.92	36.86	44.19	34.81	33.51	35.52	0.013795	6.83	104.96	29.09	0.57
Aiea Stream	301+22	5yr	669	29.85	37.33	44.56	34.15	33.27	35.00	0.030508	7.54	96.22	29.26	0.66
Aiea Stream	300+95	5yr	669	28.31	35.42	44.40	33.56	32.27	34.28	0.018979	6.95	107.46	30.18	0.57
Aiea Stream	300+68	5yr	669	26.00	34.44	43.24	33.44	30.42	33.79	0.006242	4.88	153.97	29.71	0.34
Aiea Stream	300+42	5yr	669	25.80	32.00	42.75	33.29	30.28	33.63	0.005878	4.79	176.34	57.76	0.34
Aiea Stream	300+16	5yr	669	26.54	33.39	42.75	33.06	30.30	33.46	0.006995	5.31	154.95	35.06	0.37

HEC-RAS Profile Output Table for Shotcrete Wall n=0.05: 10-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	10yr	919	63.94	75.75	75.64	69.10	68.28	70.36	0.020119	9.04	105.63	25.99	0.74
Aiea Stream	310+87	10yr	919	63.36	75.59	76.00	68.01	67.61	69.42	0.051175	9.54	98.84	27.70	0.84
Aiea Stream	310+57	10yr	919	61.97	74.77	74.51	66.85	66.15	68.12	0.031888	9.07	105.80	27.61	0.76
Aiea Stream	310+25	10yr	919	61.02	76.57	78.00	65.69	65.16	66.96	0.042520	9.09	104.82	29.72	0.80
Aiea Stream	309+97	10yr	919	60.00	76.05	76.01	65.35	63.91	66.13	0.006253	7.12	135.25	33.21	0.57
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	10yr	919	59.00	69.53	71.80	63.16	62.80	64.62	0.034013	9.70	95.50	25.17	0.86
Aiea Stream	309+32	10yr	919	57.00	67.00	71.56	62.70	61.85	64.07	0.025877	9.57	99.95	20.75	0.72
Aiea Stream	309+08	10yr	919	55.95	68.00	71.56	61.39	61.39	63.57	0.009124	11.90	83.50	22.82	0.97
Aiea Stream	308+89	10yr	919	55.45	66.42	71.56	60.05	60.84	63.23	0.015555	14.36	69.06	21.05	1.27
Aiea Stream	308+69	10yr	919	54.64	63.64	71.56	58.50	59.75	62.69	0.028407	16.47	58.49	22.44	1.67
Aiea Stream	308+54	10yr	919	53.98	60.90	71.56	55.87	57.34	61.45	0.078953	18.96	48.51	29.02	2.58
Aiea Stream	308+42	10yr	919	47.45	60.58	60.48	48.68	50.45	57.70	0.199467	24.10	38.13	31.07	3.83
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	10yr	919	45.70	57.64	60.00	51.49	49.42	51.98	0.009571	5.59	165.80	34.35	0.44
Aiea Stream	306+46	10yr	919	44.78	57.97	58.00	51.21	49.34	51.77	0.010685	6.04	154.88	33.20	0.48
Aiea Stream	306+29	10yr	919	41.50	57.93	62.00	51.19	47.17	51.56	0.004611	4.90	192.32	29.21	0.32
Aiea Stream	306+09	10yr	919	45.04	59.90	62.18	50.16	49.39	51.32	0.040644	8.74	110.59	29.09	0.72
Aiea Stream	305+79	10yr	919	43.94	58.80	59.99	49.39	48.36	50.41	0.015041	8.18	118.43	30.02	0.67
Aiea Stream	305+51	10yr	919	43.74	57.99	61.99	48.12	47.84	49.67	0.054786	10.06	94.14	26.00	0.87
Aiea Stream	305+23	10yr	919	42.18	58.00	59.98	46.31	46.14	47.92	0.067165	10.20	91.47	25.62	0.92
Aiea Stream	304+92	10yr	919	39.37	58.17	58.09	45.19	43.91	46.24	0.027465	8.31	115.07	24.87	0.64
Aiea Stream	304+84	10yr	919	38.00	58.00	58.05	45.12	43.31	46.05	0.012795	7.84	123.80	25.02	0.56
Aiea Stream	304+64	10yr	919	38.44	58.02	57.80	44.71	43.29	45.76	0.015438	8.29	116.43	24.85	0.62
Aiea Stream	304+44	10yr	919	38.98	48.21	56.10	43.92	43.34	45.23	0.046596	9.33	106.89	31.22	0.77
Aiea Stream	304+21	10yr	919	37.88	46.67	54.00	42.04	42.03	43.78	0.084485	10.67	91.33	28.55	0.96
Aiea Stream	303+93	10yr	919	36.07	46.36	55.00	40.93	40.41	42.10	0.019581	8.78	114.39	34.11	0.78
Aiea Stream	303+59	10yr	919	34.42	44.21	53.95	40.34	39.41	41.48	0.016221	8.78	116.12	27.90	0.70
Aiea Stream	303+19	10yr	919	32.80	42.83	50.15	39.72	38.37	40.89	0.014109	8.76	111.43	23.59	0.65
Aiea Stream	302+92	10yr	919	31.98	41.74	48.20	38.47	37.99	40.21	0.051707	10.78	92.68	21.85	0.82
Aiea Stream	302+50	10yr	919	29.80	40.81	45.50	37.60	35.43	38.55	0.013645	7.87	122.03	19.49	0.54
Aiea Stream	302+10	10yr	919	30.40	40.07	43.27	36.88	35.12	37.83	0.024644	7.85	117.69	20.78	0.58
Aiea Stream	301+78	10yr	919	29.98	39.79	43.21	36.36	34.27	37.08	0.016323	6.89	142.19	31.32	0.50
Aiea Stream	301+49	10yr	919	29.92	36.86	44.19	35.74	34.25	36.62	0.013360	7.64	133.35	37.60	0.58
Aiea Stream	301+22	10yr	919	29.85	37.33	44.56	35.22	34.01	36.14	0.025002	7.97	129.56	32.93	0.62
Aiea Stream	300+95	10yr	919	28.31	35.42	44.40	34.75	33.04	35.54	0.015591	7.35	144.73	32.42	0.54
Aiea Stream	300+68	10yr	919	26.00	34.44	43.24	34.64	31.20	35.12	0.006637	5.66	194.64	63.56	0.37
Aiea Stream	300+42	10yr	919	25.80	32.00	42.75	34.58	31.02	34.92	0.005120	5.07	267.88	84.22	0.33
Aiea Stream	300+16	10yr	919	26.54	33.39	42.75	34.27	31.09	34.76	0.007004	5.98	205.54	53.13	0.38

HEC-RAS Profile Output Table for Shotcrete Wall n=0.05: 25-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	25yr	1916	63.94	75.75	75.64	71.30	70.71	73.70	0.023202	12.58	167.56	30.35	0.85
Aiea Stream	310+87	25yr	1916	63.36	75.59	76.00	70.45	69.87	72.67	0.043379	12.09	173.64	33.46	0.84
Aiea Stream	310+57	25yr	1916	61.97	74.77	74.51	69.54	68.49	71.54	0.027188	11.50	188.33	33.81	0.76
Aiea Stream	310+25	25yr	1916	61.02	76.57	78.00	69.18	67.38	70.60	0.021376	9.76	225.55	39.43	0.63
Aiea Stream	309+97	25yr	1916	60.00	76.05	76.01	69.16	66.03	70.10	0.003569	7.96	281.71	43.58	0.48
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	25yr	1916	59.00	69.53	71.80	67.06	65.05	68.61	0.014529	10.06	197.64	27.22	0.63
Aiea Stream	309+32	25yr	1916	57.00	67.00	71.56	65.96	64.36	68.13	0.022201	12.14	167.78	20.79	0.73
Aiea Stream	309+08	25yr	1916	55.95	68.00	71.56	64.13	64.13	67.63	0.008137	15.28	150.03	25.75	0.99
Aiea Stream	308+89	25yr	1916	55.45	66.42	71.56	62.53	63.58	67.31	0.012548	17.85	134.60	28.53	1.24
Aiea Stream	308+69	25yr	1916	54.64	63.64	71.56	60.51	62.38	66.82	0.021850	20.31	110.53	31.02	1.60
Aiea Stream	308+54	25yr	1916	53.98	60.90	71.56	57.02	59.33	65.53	0.059878	23.41	82.31	29.44	2.45
Aiea Stream	308+42	25yr	1916	47.45	60.58	60.48	49.63	52.35	62.01	0.136623	28.23	67.86	31.08	3.37
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	25yr	1916	45.70	57.64	60.00	54.41	51.25	55.23	0.008747	7.28	267.74	35.46	0.46
Aiea Stream	306+46	25yr	1916	44.78	57.97	58.00	54.09	51.25	55.02	0.009708	7.81	252.99	34.96	0.49
Aiea Stream	306+29	25yr	1916	41.50	57.93	62.00	54.02	49.47	54.83	0.006590	7.28	277.92	31.23	0.40
Aiea Stream	306+09	25yr	1916	45.04	59.90	62.18	52.73	51.69	54.52	0.035554	11.03	193.08	35.21	0.73
Aiea Stream	305+79	25yr	1916	43.94	58.80	59.99	52.11	50.64	53.69	0.013036	10.33	209.92	37.22	0.67
Aiea Stream	305+51	25yr	1916	43.74	57.99	61.99	50.21	50.21	52.89	0.056082	13.37	153.82	31.43	0.95
Aiea Stream	305+23	25yr	1916	42.18	58.00	59.98	48.64	48.44	51.16	0.056775	12.88	155.28	29.70	0.91
Aiea Stream	304+92	25yr	1916	39.37	58.17	58.09	47.62	46.39	49.57	0.031602	11.47	179.66	28.21	0.73
Aiea Stream	304+84	25yr	1916	38.00	58.00	58.05	47.48	45.97	49.38	0.017123	11.31	188.32	29.60	0.69
Aiea Stream	304+64	25yr	1916	38.44	58.02	57.80	46.58	45.88	48.92	0.024220	12.58	166.50	29.67	0.81
Aiea Stream	304+44	25yr	1916	38.98	48.21	56.10	45.89	45.76	48.24	0.054084	12.76	177.28	39.98	0.88
Aiea Stream	304+21	25yr	1916	37.88	46.67	54.00	44.64	44.36	46.95	0.058789	12.57	175.39	36.29	0.88
Aiea Stream	303+93	25yr	1916	36.07	46.36	55.00	44.25	42.44	45.60	0.010259	9.57	236.68	39.50	0.63
Aiea Stream	303+59	25yr	1916	34.42	44.21	53.95	43.62	41.73	45.20	0.011853	10.54	212.67	31.24	0.65
Aiea Stream	303+19	25yr	1916	32.80	42.83	50.15	42.78	41.10	44.69	0.013422	11.39	193.24	29.87	0.68
Aiea Stream	302+92	25yr	1916	31.98	41.74	48.20	41.28	40.88	44.02	0.048618	13.86	162.14	27.71	0.86
Aiea Stream	302+50	25yr	1916	29.80	40.81	45.50	40.28	38.11	42.35	0.018909	11.63	174.38	19.54	0.67
Aiea Stream	302+10	25yr	1916	30.40	40.07	43.27	39.33	37.63	41.37	0.032590	11.45	169.14	21.69	0.71
Aiea Stream	301+78	25yr	1916	29.98	39.79	43.21	38.93	36.74	40.24	0.019194	9.51	231.68	74.02	0.57
Aiea Stream	301+49	25yr	1916	29.92	36.86	44.19	38.60	36.61	39.74	0.011013	9.22	326.40	135.18	0.57
Aiea Stream	301+22	25yr	1916	29.85	37.33	44.56	37.86	36.23	39.30	0.023734	10.24	255.30	124.46	0.65
Aiea Stream	300+95	25yr	1916	28.31	35.42	44.40	37.65	35.30	38.62	0.012842	8.75	338.83	128.17	0.52
Aiea Stream	300+68	25yr	1916	26.00	34.44	43.24	37.62	33.47	38.21	0.006320	6.91	432.58	142.64	0.38
Aiea Stream	300+42	25yr	1916	25.80	32.00	42.75	37.60	33.76	38.01	0.004629	6.04	523.00	142.19	0.33
Aiea Stream	300+16	25yr	1916	26.54	33.39	42.75	37.21	33.30	37.85	0.007004	7.44	431.45	111.80	0.41

HEC-RAS Profile Output Table for Shotcrete Wall n=0.05: 50-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	50yr	2321	63.94	75.75	75.64	72.13	71.55	74.88	0.022918	13.49	193.41	32.00	0.86
Aiea Stream	310+87	50yr	2321	63.36	75.59	76.00	71.48	70.66	73.84	0.037998	12.50	209.10	35.32	0.81
Aiea Stream	310+57	50yr	2321	61.97	74.77	74.51	70.76	69.30	72.83	0.023050	11.77	231.34	36.86	0.72
Aiea Stream	310+25	50yr	2321	61.02	76.57	78.00	70.60	68.15	71.99	0.016982	9.77	284.29	43.37	0.58
Aiea Stream	309+97	50yr	2321	60.00	76.05	76.01	70.62	66.76	71.58	0.003011	8.12	347.71	47.13	0.45
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	50yr	2321	59.00	69.53	71.80	68.45	65.83	70.08	0.012241	10.30	236.22	27.96	0.60
Aiea Stream	309+32	50yr	2321	57.00	67.00	71.56	67.10	65.26	69.57	0.021517	12.97	192.75	26.99	0.73
Aiea Stream	309+08	50yr	2321	55.95	68.00	71.56	65.07	65.07	69.06	0.007940	16.34	174.77	26.76	1.00
Aiea Stream	308+89	50yr	2321	55.45	66.42	71.56	63.36	64.51	68.73	0.012120	19.01	158.60	29.57	1.24
Aiea Stream	308+69	50yr	2321	54.64	63.64	71.56	61.16	63.24	68.23	0.021011	21.60	131.10	32.21	1.60
Aiea Stream	308+54	50yr	2321	53.98	60.90	71.56	57.44	60.04	66.92	0.055635	24.72	94.61	29.60	2.42
Aiea Stream	308+42	50yr	2321	47.45	60.58	60.48	49.99	53.02	63.44	0.124825	29.43	78.85	31.08	3.26
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	50yr	2321	45.70	57.64	60.00	55.36	51.89	56.31	0.008756	7.86	301.44	35.83	0.47
Aiea Stream	306+46	50yr	2321	44.78	57.97	58.00	55.01	51.91	56.08	0.009735	8.43	285.47	35.54	0.50
Aiea Stream	306+29	50yr	2321	41.50	57.93	62.00	54.91	50.27	55.91	0.007237	8.07	306.13	31.84	0.43
Aiea Stream	306+09	50yr	2321	45.04	59.90	62.18	53.58	52.45	55.57	0.034441	11.71	223.96	37.28	0.73
Aiea Stream	305+79	50yr	2321	43.94	58.80	59.99	52.99	51.40	54.76	0.012780	11.03	243.58	39.49	0.68
Aiea Stream	305+51	50yr	2321	43.74	57.99	61.99	51.02	51.02	53.97	0.052789	14.08	180.45	34.19	0.94
Aiea Stream	305+23	50yr	2321	42.18	58.00	59.98	49.47	49.24	52.26	0.053596	13.60	180.55	31.74	0.91
Aiea Stream	304+92	50yr	2321	39.37	58.17	58.09	48.47	47.23	50.72	0.031911	12.36	204.24	29.41	0.74
Aiea Stream	304+84	50yr	2321	38.00	58.00	58.05	48.31	46.87	50.53	0.017809	12.29	213.63	31.22	0.71
Aiea Stream	304+64	50yr	2321	38.44	58.02	57.80	47.23	46.83	50.04	0.026114	13.82	186.74	31.86	0.86
Aiea Stream	304+44	50yr	2321	38.98	48.21	56.10	46.67	46.50	49.23	0.051343	13.41	209.95	42.79	0.87
Aiea Stream	304+21	50yr	2321	37.88	46.67	54.00	45.60	45.13	48.01	0.051845	12.96	211.69	39.54	0.84
Aiea Stream	303+93	50yr	2321	36.07	46.36	55.00	45.31	43.15	46.78	0.009387	10.03	279.43	41.21	0.61
Aiea Stream	303+59	50yr	2321	34.42	44.21	53.95	44.61	42.53	46.40	0.011633	11.27	251.29	54.76	0.65
Aiea Stream	303+19	50yr	2321	32.80	42.83	50.15	43.78	42.05	45.89	0.013138	12.11	237.68	67.68	0.68
Aiea Stream	302+92	50yr	2321	31.98	41.74	48.20	42.21	42.21	45.23	0.047173	14.68	195.80	54.18	0.86
Aiea Stream	302+50	50yr	2321	29.80	40.81	45.50	41.00	39.07	43.62	0.021564	13.07	190.23	33.25	0.73
Aiea Stream	302+10	50yr	2321	30.40	40.07	43.27	39.86	38.51	42.50	0.038822	13.03	180.97	40.42	0.78
Aiea Stream	301+78	50yr	2321	29.98	39.79	43.21	39.46	37.57	41.11	0.022520	10.72	252.24	99.92	0.63
Aiea Stream	301+49	50yr	2321	29.92	36.86	44.19	39.18	38.07	40.47	0.011859	10.01	380.75	154.58	0.59
Aiea Stream	301+22	50yr	2321	29.85	37.33	44.56	38.75	37.00	40.07	0.020224	10.16	339.48	153.64	0.61
Aiea Stream	300+95	50yr	2321	28.31	35.42	44.40	38.53	37.01	39.49	0.011867	8.97	413.61	158.56	0.51
Aiea Stream	300+68	50yr	2321	26.00	34.44	43.24	38.48	34.25	39.12	0.006432	7.35	503.11	165.25	0.39
Aiea Stream	300+42	50yr	2321	25.80	32.00	42.75	38.46	34.79	38.92	0.004798	6.48	595.15	158.58	0.34
Aiea Stream	300+16	50yr	2321	26.54	33.39	42.75	38.07	34.72	38.75	0.007001	7.84	506.07	129.07	0.41

HEC-RAS Profile Output Table for Shotcrete Wall n=0.05: 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	100yr	2743	63.94	75.75	75.64	73.04	72.36	76.03	0.021658	14.13	223.43	33.96	0.85
Aiea Stream	310+87	100yr	2743	63.36	75.59	76.00	72.62	71.40	75.02	0.032384	12.69	250.35	37.28	0.76
Aiea Stream	310+57	100yr	2743	61.97	74.77	74.51	72.06	70.05	74.14	0.019366	11.88	280.79	39.37	0.68
Aiea Stream	310+25	100yr	2743	61.02	76.57	78.00	72.04	68.88	73.40	0.013881	9.75	349.43	47.33	0.53
Aiea Stream	309+97	100yr	2743	60.00	76.05	76.01	72.07	67.48	73.05	0.002600	8.25	418.78	50.75	0.43
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	100yr	2743	59.00	69.53	71.80	69.78	66.59	71.51	0.010869	10.62	273.86	29.49	0.58
Aiea Stream	309+32	100yr	2743	57.00	67.00	71.56	68.28	66.13	70.98	0.020375	13.61	225.73	31.07	0.72
Aiea Stream	309+08	100yr	2743	55.95	68.00	71.56	66.01	66.01	70.46	0.007731	17.31	200.24	27.77	1.00
Aiea Stream	308+89	100yr	2743	55.45	66.42	71.56	64.17	65.44	70.12	0.011757	20.09	182.90	30.58	1.24
Aiea Stream	308+69	100yr	2743	54.64	63.64	71.56	61.79	64.12	69.62	0.020372	22.82	151.71	33.36	1.60
Aiea Stream	308+54	100yr	2743	53.98	60.90	71.56	57.85	60.72	68.28	0.052244	25.93	106.80	29.75	2.39
Aiea Stream	308+42	100yr	2743	47.45	60.58	60.48	50.34	53.68	64.83	0.115695	30.54	89.81	31.08	3.17
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	100yr	2743	45.70	57.64	60.00	56.25	52.51	57.33	0.008847	8.42	333.40	36.32	0.48
Aiea Stream	306+46	100yr	2743	44.78	57.97	58.00	55.87	52.54	57.10	0.009857	9.03	316.27	36.09	0.51
Aiea Stream	306+29	100yr	2743	41.50	57.93	62.00	55.74	51.03	56.93	0.007876	8.84	332.81	32.40	0.45
Aiea Stream	306+09	100yr	2743	45.04	59.90	62.18	54.38	53.21	56.58	0.033648	12.34	254.80	39.31	0.74
Aiea Stream	305+79	100yr	2743	43.94	58.80	59.99	53.81	52.16	55.78	0.012662	11.69	276.86	41.61	0.68
Aiea Stream	305+51	100yr	2743	43.74	57.99	61.99	51.80	51.80	54.99	0.050079	14.71	208.07	36.63	0.93
Aiea Stream	305+23	100yr	2743	42.18	58.00	59.98	50.27	50.01	53.30	0.050848	14.24	206.73	33.70	0.90
Aiea Stream	304+92	100yr	2743	39.37	58.17	58.09	49.29	48.06	51.83	0.032161	13.19	228.67	30.55	0.76
Aiea Stream	304+84	100yr	2743	38.00	58.00	58.05	49.11	47.74	51.64	0.018373	13.18	239.05	33.10	0.73
Aiea Stream	304+64	100yr	2743	38.44	58.02	57.80	47.84	47.69	51.11	0.027985	15.01	206.51	33.86	0.90
Aiea Stream	304+44	100yr	2743	38.98	48.21	56.10	47.42	47.26	50.17	0.049365	14.03	242.68	45.38	0.87
Aiea Stream	304+21	100yr	2743	37.88	46.67	54.00	46.39	45.89	49.00	0.049396	13.54	244.46	42.40	0.84
Aiea Stream	303+93	100yr	2743	36.07	46.36	55.00	46.15	43.83	47.80	0.009417	10.70	314.26	42.56	0.62
Aiea Stream	303+59	100yr	2743	34.42	44.21	53.95	45.40	43.32	47.41	0.011907	12.05	292.20	80.53	0.67
Aiea Stream	303+19	100yr	2743	32.80	42.83	50.15	44.47	43.10	46.88	0.013988	13.07	272.63	93.40	0.71
Aiea Stream	302+92	100yr	2743	31.98	41.74	48.20	43.20	43.18	46.23	0.042943	15.01	243.13	87.93	0.83
Aiea Stream	302+50	100yr	2743	29.80	40.81	45.50	41.87	40.02	44.86	0.022335	14.05	230.48	66.91	0.75
Aiea Stream	302+10	100yr	2743	30.40	40.07	43.27	40.40	39.39	43.62	0.043975	14.44	203.47	74.10	0.84
Aiea Stream	301+78	100yr	2743	29.98	39.79	43.21	40.05	38.33	42.00	0.024785	11.73	287.80	130.71	0.67
Aiea Stream	301+49	100yr	2743	29.92	36.86	44.19	39.89	38.70	41.23	0.011565	10.41	448.17	177.27	0.59
Aiea Stream	301+22	100yr	2743	29.85	37.33	44.56	39.61	37.15	40.82	0.017573	10.08	420.15	181.55	0.58
Aiea Stream	300+95	100yr	2743	28.31	35.42	44.40	39.36	37.54	40.33	0.011183	9.21	484.40	187.32	0.50
Aiea Stream	300+68	100yr	2743	26.00	34.44	43.24	39.29	34.18	39.98	0.006532	7.76	570.19	186.74	0.39
Aiea Stream	300+42	100yr	2743	25.80	32.00	42.75	39.27	35.36	39.78	0.004956	6.90	663.71	174.16	0.35
Aiea Stream	300+16	100yr	2743	26.54	33.39	42.75	38.89	35.69	39.61	0.007006	8.22	577.01	145.48	0.42

HEC-RAS Profile Output Table for Shotcrete Wall n=0.05: USACE 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Chnl Fr #
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Aiea Stream	311+19	USACE100yr	3850	63.94	75.75	75.64	77.04	74.31	79.48	0.010990	13.00	377.33	41.28	0.65
Aiea Stream	310+87	USACE100yr	3850	63.36	75.59	76.00	77.06	73.18	78.89	0.014705	11.29	432.41	43.17	0.55
Aiea Stream	310+57	USACE100yr	3850	61.97	74.77	74.51	76.85	71.96	78.47	0.009111	10.67	487.07	44.43	0.50
Aiea Stream	310+25	USACE100yr	3850	61.02	76.57	78.00	77.04	70.62	78.04	0.006429	8.62	620.47	60.98	0.39
Aiea Stream	309+97	USACE100yr	3850	60.00	76.05	76.01	77.06	69.17	77.87	0.001386	7.66	699.60	59.56	0.33
Aiea Stream	309+91		Culvert											
Aiea Stream	309+49	USACE100yr	3850	59.00	69.53	71.80	72.80	68.46	74.75	0.008920	11.38	381.88	43.86	0.54
Aiea Stream	309+32	USACE100yr	3850	57.00	67.00	71.56	71.80	68.78	74.38	0.014196	13.67	361.97	40.56	0.63
Aiea Stream	309+08	USACE100yr	3850	55.95	68.00	71.56	68.38	68.38	73.83	0.007040	19.22	274.23	36.22	0.99
Aiea Stream	308+89	USACE100yr	3850	55.45	66.42	71.56	66.11	67.69	73.47	0.011041	22.46	244.60	33.19	1.25
Aiea Stream	308+69	USACE100yr	3850	54.64	63.64	71.56	63.28	66.07	72.94	0.019213	25.52	203.81	36.51	1.61
Aiea Stream	308+54	USACE100yr	3850	53.98	60.90	71.56	58.85	62.45	71.53	0.046177	28.61	136.55	30.11	2.34
Aiea Stream	308+42	USACE100yr	3850	47.45	60.58	60.48	51.20	55.26	68.12	0.095387	33.01	116.63	31.08	3.00
Aiea Stream	308+41		Culvert											
Aiea Stream	306+62	USACE100yr	3850	45.70	57.64	60.00	58.29	54.02	59.73	0.009116	9.71	410.77	41.83	0.50
Aiea Stream	306+46	USACE100yr	3850	44.78	57.97	58.00	57.85	54.11	59.47	0.010205	10.40	388.82	37.50	0.54
Aiea Stream	306+29	USACE100yr	3850	41.50	57.93	62.00	57.57	52.85	59.28	0.009452	10.65	393.15	33.64	0.51
Aiea Stream	306+09	USACE100yr	3850	45.04	59.90	62.18	56.22	54.93	58.90	0.032499	13.77	331.41	44.86	0.75
Aiea Stream	305+79	USACE100yr	3850	43.94	58.80	59.99	55.65	53.90	58.12	0.012677	13.23	358.72	47.59	0.71
Aiea Stream	305+51	USACE100yr	3850	43.74	57.99	61.99	53.58	53.58	57.33	0.045595	16.10	278.03	41.95	0.92
Aiea Stream	305+23	USACE100yr	3850	42.18	58.00	59.98	52.03	51.84	55.71	0.047765	15.81	270.22	38.38	0.90
Aiea Stream	304+92	USACE100yr	3850	39.37	58.17	58.09	50.90	49.93	54.32	0.035678	15.44	279.99	33.42	0.82
Aiea Stream	304+84	USACE100yr	3850	38.00	58.00	58.05	50.43	49.78	54.08	0.022766	15.95	286.40	37.96	0.83
Aiea Stream	304+64	USACE100yr	3850	38.44	58.02	57.80	49.71	49.71	53.56	0.026287	16.56	275.74	40.07	0.90
Aiea Stream	304+44	USACE100yr	3850	38.98	48.21	56.10	48.02	49.06	52.44	0.072779	17.88	270.84	47.64	1.07
Aiea Stream	304+21	USACE100yr	3850	37.88	46.67	54.00	48.28	48.14	51.07	0.042288	14.40	352.69	77.05	0.80
Aiea Stream	303+93	USACE100yr	3850	36.07	46.36	55.00	47.93	45.47	50.10	0.009907	12.37	416.00	76.71	0.66
Aiea Stream	303+59	USACE100yr	3850	34.42	44.21	53.95	47.17	45.62	49.70	0.012540	13.78	386.41	138.97	0.71
Aiea Stream	303+19	USACE100yr	3850	32.80	42.83	50.15	45.82	45.41	49.08	0.016731	15.51	344.01	143.88	0.80
Aiea Stream	302+92	USACE100yr	3850	31.98	41.74	48.20	45.21	44.97	48.41	0.038423	16.03	345.59	156.82	0.81
Aiea Stream	302+50	USACE100yr	3850	29.80	40.81	45.50	43.78	43.78	47.14	0.021765	15.46	349.40	157.27	0.76
Aiea Stream	302+10	USACE100yr	3850	30.40	40.07	43.27	42.47	42.47	45.94	0.038614	15.47	314.47	168.14	0.81
Aiea Stream	301+78	USACE100yr	3850	29.98	39.79	43.21	41.78	41.03	43.80	0.022580	12.50	440.66	211.46	0.65
Aiea Stream	301+49	USACE100yr	3850	29.92	36.86	44.19	41.67	39.97	43.08	0.010513	11.13	616.62	230.67	0.58
Aiea Stream	301+22	USACE100yr	3850	29.85	37.33	44.56	41.57	39.75	42.66	0.013696	10.09	606.71	237.53	0.52
Aiea Stream	300+95	USACE100yr	3850	28.31	35.42	44.40	41.29	38.70	42.31	0.010120	9.82	648.44	241.77	0.49
Aiea Stream	300+68	USACE100yr	3850	26.00	34.44	43.24	41.19	37.38	42.00	0.006713	8.67	726.53	227.20	0.41
Aiea Stream	300+42	USACE100yr	3850	25.80	32.00	42.75	41.17	36.50	41.79	0.005275	7.83	823.45	209.00	0.37
Aiea Stream	300+16	USACE100yr	3850	26.54	33.39	42.75	40.81	37.27	41.62	0.007003	9.06	742.38	183.74	0.43

APPENDIX 19

HEC-RAS Model Results Comparison for Water Surface

HEC-RAS Profile Water Surface Comparision: 2-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev Existing	W.S. Elev Proposed n=0.03	W.S.Diff n=0.03	W.S. Elev Proposed n=0.05	W.S.Diff n=0.05
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
Aiea Stream	311+19	2yr	375	63.94	75.75	75.64	67.32	67.32	0.00	67.32	0.00
Aiea Stream	310+87	2yr	375	63.36	75.59	76.00	66.30	66.30	0.00	66.30	0.00
Aiea Stream	310+57	2yr	375	61.97	74.77	74.51	65.19	65.19	0.00	65.19	0.00
Aiea Stream	310+25	2yr	375	61.02	76.57	78.00	63.71	63.71	0.00	63.71	0.00
Aiea Stream	309+97	2yr	375	60.00	76.05	76.01	62.69	62.69	0.00	62.69	0.00
Aiea Stream	309+91		Culvert								
Aiea Stream	309+49	2yr	375	59.00	69.53	71.80	61.20	61.20	0.00	61.20	0.00
Aiea Stream	309+32	2yr	375	57.00	67.00	71.56	60.28	60.28	0.00	60.28	0.00
Aiea Stream	309+08	2yr	375	55.95	68.00	71.56	59.24	59.24	0.00	59.24	0.00
Aiea Stream	308+89	2yr	375	55.45	66.42	71.56	58.16	58.16	0.00	58.16	0.00
Aiea Stream	308+69	2yr	375	54.64	63.64	71.56	57.13	57.13	0.00	57.13	0.00
Aiea Stream	308+54	2yr	375	53.98	60.90	71.56	55.10	55.10	0.00	55.10	0.00
Aiea Stream	308+42	2yr	375	47.45	60.58	60.48	48.07	48.07	0.00	48.07	0.00
Aiea Stream	308+41		Culvert								
Aiea Stream	306+62	2yr	375	45.70	57.64	60.00	49.38	49.23	-0.15	49.23	-0.15
Aiea Stream	306+46	2yr	375	44.78	57.97	58.00	49.14	48.92	-0.22	48.93	-0.21
Aiea Stream	306+29	2yr	375	41.50	57.93	62.00	49.12	48.90	-0.22	48.90	-0.22
Aiea Stream	306+09	2yr	375	45.04	59.90	62.18	48.41	48.27	-0.14	48.28	-0.13
Aiea Stream	305+79	2yr	375	43.94	58.80	59.99	47.50	47.41	-0.09	47.41	-0.09
Aiea Stream	305+51	2yr	375	43.74	57.99	61.99	46.54	46.56	0.02	46.57	0.03
Aiea Stream	305+23	2yr	375	42.18	58.00	59.98	44.55	44.54	-0.01	44.54	-0.01
Aiea Stream	304+92	2yr	375	39.37	58.17	58.09	43.10	43.04	-0.06	43.04	-0.06
Aiea Stream	304+84	2yr	375	38.00	58.00	58.05	43.12	43.00	-0.12	43.00	-0.12
Aiea Stream	304+64	2yr	375	38.44	58.02	57.80	42.78	42.73	-0.05	42.73	-0.05
Aiea Stream	304+44	2yr	375	38.98	48.21	56.10	42.01	42.05	0.04	42.05	0.04
Aiea Stream	304+21	2yr	375	37.88	46.67	54.00	40.55	40.54	-0.01	40.54	-0.01
Aiea Stream	303+93	2yr	375	36.07	46.36	55.00	38.99	38.99	0.00	38.99	0.00
Aiea Stream	303+59	2yr	375	34.42	44.21	53.95	37.98	37.98	0.00	37.98	0.00
Aiea Stream	303+19	2yr	375	32.80	42.83	50.15	37.29	37.29	0.00	37.29	0.00
Aiea Stream	302+92	2yr	375	31.98	41.74	48.20	36.26	36.26	0.00	36.26	0.00
Aiea Stream	302+50	2yr	375	29.80	40.81	45.50	35.23	35.23	0.00	35.23	0.00
Aiea Stream	302+10	2yr	375	30.40	40.07	43.27	34.62	34.62	0.00	34.62	0.00
Aiea Stream	301+78	2yr	375	29.98	39.79	43.21	34.10	34.10	0.00	34.10	0.00
Aiea Stream	301+49	2yr	375	29.92	36.86	44.19	33.55	33.55	0.00	33.55	0.00
Aiea Stream	301+22	2yr	375	29.85	37.33	44.56	32.81	32.81	0.00	32.81	0.00
Aiea Stream	300+95	2yr	375	28.31	35.42	44.40	31.95	31.95	0.00	31.95	0.00
Aiea Stream	300+68	2yr	375	26.00	34.44	43.24	31.72	31.72	0.00	31.72	0.00
Aiea Stream	300+42	2yr	375	25.80	32.00	42.75	31.57	31.57	0.00	31.57	0.00
Aiea Stream	300+16	2yr	375	26.54	33.39	42.75	31.35	31.35	0.00	31.35	0.00

HEC-RAS Profile Water Surface Comparision: 5-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev Existing	W.S. Elev Proposed n=0.03	W.S.Diff n=0.03	W.S. Elev Proposed n=0.05	W.S.Diff n=0.05
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
Aiea Stream	311+19	5yr	669	63.94	75.75	75.64	68.38	68.38	0.00	68.38	0.00
Aiea Stream	310+87	5yr	669	63.36	75.59	76.00	67.30	67.30	0.00	67.30	0.00
Aiea Stream	310+57	5yr	669	61.97	74.77	74.51	66.19	66.20	0.01	66.20	0.01
Aiea Stream	310+25	5yr	669	61.02	76.57	78.00	64.82	64.80	-0.02	64.80	-0.02
Aiea Stream	309+97	5yr	669	60.00	76.05	76.01	64.25	64.25	0.00	64.25	0.00
Aiea Stream	309+91		Culvert								
Aiea Stream	309+49	5yr	669	59.00	69.53	71.80	62.21	62.21	0.00	62.21	0.00
Aiea Stream	309+32	5yr	669	57.00	67.00	71.56	61.68	61.68	0.00	61.68	0.00
Aiea Stream	309+08	5yr	669	55.95	68.00	71.56	60.50	60.50	0.00	60.50	0.00
Aiea Stream	308+89	5yr	669	55.45	66.42	71.56	59.21	59.21	0.00	59.21	0.00
Aiea Stream	308+69	5yr	669	54.64	63.64	71.56	57.90	57.90	0.00	57.90	0.00
Aiea Stream	308+54	5yr	669	53.98	60.90	71.56	55.54	55.54	0.00	55.54	0.00
Aiea Stream	308+42	5yr	669	47.45	60.58	60.48	48.41	48.41	0.00	48.41	0.00
Aiea Stream	308+41		Culvert								
Aiea Stream	306+62	5yr	669	45.70	57.64	60.00	50.76	50.53	-0.23	50.55	-0.21
Aiea Stream	306+46	5yr	669	44.78	57.97	58.00	50.51	50.26	-0.25	50.27	-0.24
Aiea Stream	306+29	5yr	669	41.50	57.93	62.00	50.50	50.24	-0.26	50.25	-0.25
Aiea Stream	306+09	5yr	669	45.04	59.90	62.18	49.50	49.36	-0.14	49.37	-0.13
Aiea Stream	305+79	5yr	669	43.94	58.80	59.99	48.68	48.55	-0.13	48.56	-0.12
Aiea Stream	305+51	5yr	669	43.74	57.99	61.99	47.38	47.49	0.11	47.50	0.12
Aiea Stream	305+23	5yr	669	42.18	58.00	59.98	45.58	45.56	-0.02	45.57	-0.01
Aiea Stream	304+92	5yr	669	39.37	58.17	58.09	44.42	44.33	-0.09	44.33	-0.09
Aiea Stream	304+84	5yr	669	38.00	58.00	58.05	44.46	44.28	-0.18	44.28	-0.18
Aiea Stream	304+64	5yr	669	38.44	58.02	57.80	43.99	43.94	-0.05	43.93	-0.06
Aiea Stream	304+44	5yr	669	38.98	48.21	56.10	42.92	43.15	0.23	43.15	0.23
Aiea Stream	304+21	5yr	669	37.88	46.67	54.00	41.39	41.40	0.01	41.40	0.01
Aiea Stream	303+93	5yr	669	36.07	46.36	55.00	40.04	40.04	0.00	40.04	0.00
Aiea Stream	303+59	5yr	669	34.42	44.21	53.95	39.33	39.33	0.00	39.33	0.00
Aiea Stream	303+19	5yr	669	32.80	42.83	50.15	38.71	38.71	0.00	38.71	0.00
Aiea Stream	302+92	5yr	669	31.98	41.74	48.20	37.56	37.56	0.00	37.56	0.00
Aiea Stream	302+50	5yr	669	29.80	40.81	45.50	36.64	36.64	0.00	36.64	0.00
Aiea Stream	302+10	5yr	669	30.40	40.07	43.27	35.96	35.96	0.00	35.96	0.00
Aiea Stream	301+78	5yr	669	29.98	39.79	43.21	35.42	35.42	0.00	35.42	0.00
Aiea Stream	301+49	5yr	669	29.92	36.86	44.19	34.81	34.81	0.00	34.81	0.00
Aiea Stream	301+22	5yr	669	29.85	37.33	44.56	34.15	34.15	0.00	34.15	0.00
Aiea Stream	300+95	5yr	669	28.31	35.42	44.40	33.56	33.56	0.00	33.56	0.00
Aiea Stream	300+68	5yr	669	26.00	34.44	43.24	33.44	33.44	0.00	33.44	0.00
Aiea Stream	300+42	5yr	669	25.80	32.00	42.75	33.29	33.29	0.00	33.29	0.00
Aiea Stream	300+16	5yr	669	26.54	33.39	42.75	33.06	33.06	0.00	33.06	0.00

HEC-RAS Profile Water Surface Comparision: 10-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev Existing	W.S. Elev Proposed n=0.03	W.S.Diff n=0.03	W.S. Elev Proposed n=0.05	W.S.Diff n=0.05
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
Aiea Stream	311+19	10yr	919	63.94	75.75	75.64	69.10	69.10	0.00	69.10	0.00
Aiea Stream	310+87	10yr	919	63.36	75.59	76.00	68.01	68.01	0.00	68.01	0.00
Aiea Stream	310+57	10yr	919	61.97	74.77	74.51	66.84	66.85	0.01	66.85	0.01
Aiea Stream	310+25	10yr	919	61.02	76.57	78.00	65.71	65.69	-0.02	65.69	-0.02
Aiea Stream	309+97	10yr	919	60.00	76.05	76.01	65.35	65.35	0.00	65.35	0.00
Aiea Stream	309+91		Culvert								
Aiea Stream	309+49	10yr	919	59.00	69.53	71.80	63.16	63.16	0.00	63.16	0.00
Aiea Stream	309+32	10yr	919	57.00	67.00	71.56	62.70	62.70	0.00	62.70	0.00
Aiea Stream	309+08	10yr	919	55.95	68.00	71.56	61.39	61.39	0.00	61.39	0.00
Aiea Stream	308+89	10yr	919	55.45	66.42	71.56	60.05	60.05	0.00	60.05	0.00
Aiea Stream	308+69	10yr	919	54.64	63.64	71.56	58.50	58.50	0.00	58.50	0.00
Aiea Stream	308+54	10yr	919	53.98	60.90	71.56	55.87	55.87	0.00	55.87	0.00
Aiea Stream	308+42	10yr	919	47.45	60.58	60.48	48.68	48.68	0.00	48.68	0.00
Aiea Stream	308+41		Culvert								
Aiea Stream	306+62	10yr	919	45.70	57.64	60.00	51.75	51.46	-0.29	51.49	-0.26
Aiea Stream	306+46	10yr	919	44.78	57.97	58.00	51.48	51.19	-0.29	51.21	-0.27
Aiea Stream	306+29	10yr	919	41.50	57.93	62.00	51.47	51.17	-0.30	51.19	-0.28
Aiea Stream	306+09	10yr	919	45.04	59.90	62.18	50.32	50.14	-0.18	50.16	-0.16
Aiea Stream	305+79	10yr	919	43.94	58.80	59.99	49.58	49.38	-0.20	49.39	-0.19
Aiea Stream	305+51	10yr	919	43.74	57.99	61.99	47.97	48.10	0.13	48.12	0.15
Aiea Stream	305+23	10yr	919	42.18	58.00	59.98	46.36	46.30	-0.06	46.31	-0.05
Aiea Stream	304+92	10yr	919	39.37	58.17	58.09	45.34	45.18	-0.16	45.19	-0.15
Aiea Stream	304+84	10yr	919	38.00	58.00	58.05	45.40	45.13	-0.27	45.12	-0.28
Aiea Stream	304+64	10yr	919	38.44	58.02	57.80	44.84	44.74	-0.10	44.71	-0.13
Aiea Stream	304+44	10yr	919	38.98	48.21	56.10	43.51	43.92	0.41	43.92	0.41
Aiea Stream	304+21	10yr	919	37.88	46.67	54.00	42.04	42.04	0.00	42.04	0.00
Aiea Stream	303+93	10yr	919	36.07	46.36	55.00	40.93	40.93	0.00	40.93	0.00
Aiea Stream	303+59	10yr	919	34.42	44.21	53.95	40.34	40.34	0.00	40.34	0.00
Aiea Stream	303+19	10yr	919	32.80	42.83	50.15	39.72	39.72	0.00	39.72	0.00
Aiea Stream	302+92	10yr	919	31.98	41.74	48.20	38.47	38.47	0.00	38.47	0.00
Aiea Stream	302+50	10yr	919	29.80	40.81	45.50	37.60	37.60	0.00	37.60	0.00
Aiea Stream	302+10	10yr	919	30.40	40.07	43.27	36.88	36.88	0.00	36.88	0.00
Aiea Stream	301+78	10yr	919	29.98	39.79	43.21	36.36	36.36	0.00	36.36	0.00
Aiea Stream	301+49	10yr	919	29.92	36.86	44.19	35.74	35.74	0.00	35.74	0.00
Aiea Stream	301+22	10yr	919	29.85	37.33	44.56	35.22	35.22	0.00	35.22	0.00
Aiea Stream	300+95	10yr	919	28.31	35.42	44.40	34.75	34.75	0.00	34.75	0.00
Aiea Stream	300+68	10yr	919	26.00	34.44	43.24	34.64	34.64	0.00	34.64	0.00
Aiea Stream	300+42	10yr	919	25.80	32.00	42.75	34.58	34.58	0.00	34.58	0.00
Aiea Stream	300+16	10yr	919	26.54	33.39	42.75	34.27	34.27	0.00	34.27	0.00

HEC-RAS Profile Water Surface Comparision: 25-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev Existing	W.S. Elev Proposed n=0.03	W.S.Diff n=0.03	W.S. Elev Proposed n=0.05	W.S.Diff n=0.05
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
Aiea Stream	311+19	25yr	1916	63.94	75.75	75.64	71.30	71.30	0.00	71.30	0.00
Aiea Stream	310+87	25yr	1916	63.36	75.59	76.00	70.44	70.45	0.01	70.45	0.01
Aiea Stream	310+57	25yr	1916	61.97	74.77	74.51	69.52	69.54	0.02	69.54	0.02
Aiea Stream	310+25	25yr	1916	61.02	76.57	78.00	69.21	69.18	-0.03	69.18	-0.03
Aiea Stream	309+97	25yr	1916	60.00	76.05	76.01	69.16	69.16	0.00	69.16	0.00
Aiea Stream	309+91		Culvert								
Aiea Stream	309+49	25yr	1916	59.00	69.53	71.80	67.06	67.06	0.00	67.06	0.00
Aiea Stream	309+32	25yr	1916	57.00	67.00	71.56	65.96	65.96	0.00	65.96	0.00
Aiea Stream	309+08	25yr	1916	55.95	68.00	71.56	64.13	64.13	0.00	64.13	0.00
Aiea Stream	308+89	25yr	1916	55.45	66.42	71.56	62.53	62.53	0.00	62.53	0.00
Aiea Stream	308+69	25yr	1916	54.64	63.64	71.56	60.51	60.51	0.00	60.51	0.00
Aiea Stream	308+54	25yr	1916	53.98	60.90	71.56	57.02	57.02	0.00	57.02	0.00
Aiea Stream	308+42	25yr	1916	47.45	60.58	60.48	49.63	49.63	0.00	49.63	0.00
Aiea Stream	308+41		Culvert								
Aiea Stream	306+62	25yr	1916	45.70	57.64	60.00	54.81	54.37	-0.44	54.41	-0.40
Aiea Stream	306+46	25yr	1916	44.78	57.97	58.00	54.44	54.08	-0.36	54.09	-0.35
Aiea Stream	306+29	25yr	1916	41.50	57.93	62.00	54.38	54.01	-0.37	54.02	-0.36
Aiea Stream	306+09	25yr	1916	45.04	59.90	62.18	53.04	52.68	-0.36	52.73	-0.31
Aiea Stream	305+79	25yr	1916	43.94	58.80	59.99	52.46	52.17	-0.29	52.11	-0.35
Aiea Stream	305+51	25yr	1916	43.74	57.99	61.99	50.33	50.17	-0.16	50.21	-0.12
Aiea Stream	305+23	25yr	1916	42.18	58.00	59.98	48.84	48.57	-0.27	48.64	-0.20
Aiea Stream	304+92	25yr	1916	39.37	58.17	58.09	47.94	47.58	-0.36	47.62	-0.32
Aiea Stream	304+84	25yr	1916	38.00	58.00	58.05	48.01	47.49	-0.52	47.48	-0.53
Aiea Stream	304+64	25yr	1916	38.44	58.02	57.80	47.13	46.78	-0.35	46.58	-0.55
Aiea Stream	304+44	25yr	1916	38.98	48.21	56.10	45.83	45.89	0.06	45.89	0.06
Aiea Stream	304+21	25yr	1916	37.88	46.67	54.00	44.76	44.64	-0.12	44.64	-0.12
Aiea Stream	303+93	25yr	1916	36.07	46.36	55.00	44.25	44.25	0.00	44.25	0.00
Aiea Stream	303+59	25yr	1916	34.42	44.21	53.95	43.62	43.62	0.00	43.62	0.00
Aiea Stream	303+19	25yr	1916	32.80	42.83	50.15	42.78	42.78	0.00	42.78	0.00
Aiea Stream	302+92	25yr	1916	31.98	41.74	48.20	41.28	41.28	0.00	41.28	0.00
Aiea Stream	302+50	25yr	1916	29.80	40.81	45.50	40.28	40.28	0.00	40.28	0.00
Aiea Stream	302+10	25yr	1916	30.40	40.07	43.27	39.33	39.33	0.00	39.33	0.00
Aiea Stream	301+78	25yr	1916	29.98	39.79	43.21	38.93	38.93	0.00	38.93	0.00
Aiea Stream	301+49	25yr	1916	29.92	36.86	44.19	38.60	38.60	0.00	38.60	0.00
Aiea Stream	301+22	25yr	1916	29.85	37.33	44.56	37.86	37.86	0.00	37.86	0.00
Aiea Stream	300+95	25yr	1916	28.31	35.42	44.40	37.65	37.65	0.00	37.65	0.00
Aiea Stream	300+68	25yr	1916	26.00	34.44	43.24	37.62	37.62	0.00	37.62	0.00
Aiea Stream	300+42	25yr	1916	25.80	32.00	42.75	37.60	37.60	0.00	37.60	0.00
Aiea Stream	300+16	25yr	1916	26.54	33.39	42.75	37.21	37.21	0.00	37.21	0.00

HEC-RAS Profile Water Surface Comparision: 50-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev Existing	W.S. Elev Proposed n=0.03	W.S.Diff n=0.03	W.S. Elev Proposed n=0.05	W.S.Diff n=0.05
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
Aiea Stream	311+19	50yr	2321	63.94	75.75	75.64	72.12	72.13	0.01	72.13	0.01
Aiea Stream	310+87	50yr	2321	63.36	75.59	76.00	71.47	71.48	0.01	71.48	0.01
Aiea Stream	310+57	50yr	2321	61.97	74.77	74.51	70.74	70.76	0.02	70.76	0.02
Aiea Stream	310+25	50yr	2321	61.02	76.57	78.00	70.62	70.60	-0.02	70.60	-0.02
Aiea Stream	309+97	50yr	2321	60.00	76.05	76.01	70.62	70.62	0.00	70.62	0.00
Aiea Stream	309+91		Culvert						0.00		0.00
Aiea Stream	309+49	50yr	2321	59.00	69.53	71.80	68.45	68.45	0.00	68.45	0.00
Aiea Stream	309+32	50yr	2321	57.00	67.00	71.56	67.10	67.10	0.00	67.10	0.00
Aiea Stream	309+08	50yr	2321	55.95	68.00	71.56	65.07	65.07	0.00	65.07	0.00
Aiea Stream	308+89	50yr	2321	55.45	66.42	71.56	63.36	63.36	0.00	63.36	0.00
Aiea Stream	308+69	50yr	2321	54.64	63.64	71.56	61.16	61.16	0.00	61.16	0.00
Aiea Stream	308+54	50yr	2321	53.98	60.90	71.56	57.44	57.44	0.00	57.44	0.00
Aiea Stream	308+42	50yr	2321	47.45	60.58	60.48	49.99	49.99	0.00	49.99	0.00
Aiea Stream	308+41		Culvert						0.00		0.00
Aiea Stream	306+62	50yr	2321	45.70	57.64	60.00	55.82	55.33	-0.49	55.36	-0.46
Aiea Stream	306+46	50yr	2321	44.78	57.97	58.00	55.40	55.02	-0.38	55.01	-0.39
Aiea Stream	306+29	50yr	2321	41.50	57.93	62.00	55.33	54.93	-0.40	54.91	-0.42
Aiea Stream	306+09	50yr	2321	45.04	59.90	62.18	54.00	53.55	-0.45	53.58	-0.42
Aiea Stream	305+79	50yr	2321	43.94	58.80	59.99	53.43	53.10	-0.33	52.99	-0.44
Aiea Stream	305+51	50yr	2321	43.74	57.99	61.99	51.17	50.97	-0.20	51.02	-0.15
Aiea Stream	305+23	50yr	2321	42.18	58.00	59.98	49.65	48.96	-0.69	49.47	-0.18
Aiea Stream	304+92	50yr	2321	39.37	58.17	58.09	48.70	48.33	-0.37	48.47	-0.23
Aiea Stream	304+84	50yr	2321	38.00	58.00	58.05	48.77	48.24	-0.53	48.31	-0.46
Aiea Stream	304+64	50yr	2321	38.44	58.02	57.80	47.75	47.29	-0.46	47.23	-0.52
Aiea Stream	304+44	50yr	2321	38.98	48.21	56.10	46.61	46.67	0.06	46.67	0.06
Aiea Stream	304+21	50yr	2321	37.88	46.67	54.00	45.75	45.60	-0.15	45.60	-0.15
Aiea Stream	303+93	50yr	2321	36.07	46.36	55.00	45.31	45.31	0.00	45.31	0.00
Aiea Stream	303+59	50yr	2321	34.42	44.21	53.95	44.61	44.61	0.00	44.61	0.00
Aiea Stream	303+19	50yr	2321	32.80	42.83	50.15	43.78	43.78	0.00	43.78	0.00
Aiea Stream	302+92	50yr	2321	31.98	41.74	48.20	42.21	42.21	0.00	42.21	0.00
Aiea Stream	302+50	50yr	2321	29.80	40.81	45.50	41.00	41.00	0.00	41.00	0.00
Aiea Stream	302+10	50yr	2321	30.40	40.07	43.27	39.86	39.86	0.00	39.86	0.00
Aiea Stream	301+78	50yr	2321	29.98	39.79	43.21	39.46	39.46	0.00	39.46	0.00
Aiea Stream	301+49	50yr	2321	29.92	36.86	44.19	39.18	39.18	0.00	39.18	0.00
Aiea Stream	301+22	50yr	2321	29.85	37.33	44.56	38.75	38.75	0.00	38.75	0.00
Aiea Stream	300+95	50yr	2321	28.31	35.42	44.40	38.53	38.53	0.00	38.53	0.00
Aiea Stream	300+68	50yr	2321	26.00	34.44	43.24	38.48	38.48	0.00	38.48	0.00
Aiea Stream	300+42	50yr	2321	25.80	32.00	42.75	38.46	38.46	0.00	38.46	0.00
Aiea Stream	300+16	50yr	2321	26.54	33.39	42.75	38.07	38.07	0.00	38.07	0.00

HEC-RAS Profile Water Surface Comparision: 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev Existing	W.S. Elev Proposed n=0.03	W.S.Diff n=0.03	W.S. Elev Proposed n=0.05	W.S.Diff n=0.05
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
Aiea Stream	311+19	100yr	2743	63.94	75.75	75.64	73.03	73.04	0.01	73.04	0.01
Aiea Stream	310+87	100yr	2743	63.36	75.59	76.00	72.61	72.62	0.01	72.62	0.01
Aiea Stream	310+57	100yr	2743	61.97	74.77	74.51	72.04	72.06	0.02	72.06	0.02
Aiea Stream	310+25	100yr	2743	61.02	76.57	78.00	72.06	72.04	-0.02	72.04	-0.02
Aiea Stream	309+97	100yr	2743	60.00	76.05	76.01	72.07	72.07	0.00	72.07	0.00
Aiea Stream	309+91		Culvert						0.00		0.00
Aiea Stream	309+49	100yr	2743	59.00	69.53	71.80	69.78	69.78	0.00	69.78	0.00
Aiea Stream	309+32	100yr	2743	57.00	67.00	71.56	68.28	68.28	0.00	68.28	0.00
Aiea Stream	309+08	100yr	2743	55.95	68.00	71.56	66.01	66.01	0.00	66.01	0.00
Aiea Stream	308+89	100yr	2743	55.45	66.42	71.56	64.17	64.17	0.00	64.17	0.00
Aiea Stream	308+69	100yr	2743	54.64	63.64	71.56	61.79	61.79	0.00	61.79	0.00
Aiea Stream	308+54	100yr	2743	53.98	60.90	71.56	57.85	57.85	0.00	57.85	0.00
Aiea Stream	308+42	100yr	2743	47.45	60.58	60.48	50.34	50.34	0.00	50.34	0.00
Aiea Stream	308+41		Culvert						0.00		0.00
Aiea Stream	306+62	100yr	2743	45.70	57.64	60.00	56.78	56.24	-0.54	56.25	-0.53
Aiea Stream	306+46	100yr	2743	44.78	57.97	58.00	56.31	55.92	-0.39	55.87	-0.44
Aiea Stream	306+29	100yr	2743	41.50	57.93	62.00	56.21	55.79	-0.42	55.74	-0.47
Aiea Stream	306+09	100yr	2743	45.04	59.90	62.18	54.93	54.38	-0.55	54.38	-0.55
Aiea Stream	305+79	100yr	2743	43.94	58.80	59.99	54.36	54.00	-0.36	53.81	-0.55
Aiea Stream	305+51	100yr	2743	43.74	57.99	61.99	52.01	51.75	-0.26	51.80	-0.21
Aiea Stream	305+23	100yr	2743	42.18	58.00	59.98	50.42	49.60	-0.82	50.27	-0.15
Aiea Stream	304+92	100yr	2743	39.37	58.17	58.09	49.41	49.08	-0.33	49.29	-0.12
Aiea Stream	304+84	100yr	2743	38.00	58.00	58.05	49.47	48.98	-0.49	49.11	-0.36
Aiea Stream	304+64	100yr	2743	38.44	58.02	57.80	48.14	47.92	-0.22	47.84	-0.30
Aiea Stream	304+44	100yr	2743	38.98	48.21	56.10	47.47	47.42	-0.05	47.42	-0.05
Aiea Stream	304+21	100yr	2743	37.88	46.67	54.00	46.58	46.39	-0.19	46.39	-0.19
Aiea Stream	303+93	100yr	2743	36.07	46.36	55.00	46.15	46.15	0.00	46.15	0.00
Aiea Stream	303+59	100yr	2743	34.42	44.21	53.95	45.40	45.40	0.00	45.40	0.00
Aiea Stream	303+19	100yr	2743	32.80	42.83	50.15	44.47	44.47	0.00	44.47	0.00
Aiea Stream	302+92	100yr	2743	31.98	41.74	48.20	43.20	43.20	0.00	43.20	0.00
Aiea Stream	302+50	100yr	2743	29.80	40.81	45.50	41.87	41.87	0.00	41.87	0.00
Aiea Stream	302+10	100yr	2743	30.40	40.07	43.27	40.40	40.40	0.00	40.40	0.00
Aiea Stream	301+78	100yr	2743	29.98	39.79	43.21	40.05	40.05	0.00	40.05	0.00
Aiea Stream	301+49	100yr	2743	29.92	36.86	44.19	39.89	39.89	0.00	39.89	0.00
Aiea Stream	301+22	100yr	2743	29.85	37.33	44.56	39.61	39.61	0.00	39.61	0.00
Aiea Stream	300+95	100yr	2743	28.31	35.42	44.40	39.36	39.36	0.00	39.36	0.00
Aiea Stream	300+68	100yr	2743	26.00	34.44	43.24	39.29	39.29	0.00	39.29	0.00
Aiea Stream	300+42	100yr	2743	25.80	32.00	42.75	39.27	39.27	0.00	39.27	0.00
Aiea Stream	300+16	100yr	2743	26.54	33.39	42.75	38.89	38.89	0.00	38.89	0.00

HEC-RAS Profile Water Surface Comparision: USACE 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	L Bank El	R Bank El	W.S. Elev Existing	W.S. Elev Proposed n=0.03	W.S.Diff n=0.03	W.S. Elev Proposed n=0.05	W.S.Diff n=0.05
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
Aiea Stream	311+19	USACE100yr	3850	63.94	75.75	75.64	77.03	77.04	0.01	77.04	0.01
Aiea Stream	310+87	USACE100yr	3850	63.36	75.59	76.00	77.05	77.06	0.01	77.06	0.01
Aiea Stream	310+57	USACE100yr	3850	61.97	74.77	74.51	76.84	76.85	0.01	76.85	0.01
Aiea Stream	310+25	USACE100yr	3850	61.02	76.57	78.00	77.05	77.04	-0.01	77.04	-0.01
Aiea Stream	309+97	USACE100yr	3850	60.00	76.05	76.01	77.06	77.06	0.00	77.06	0.00
Aiea Stream	309+91		Culvert						0.00		0.00
Aiea Stream	309+49	USACE100yr	3850	59.00	69.53	71.80	72.80	72.80	0.00	72.80	0.00
Aiea Stream	309+32	USACE100yr	3850	57.00	67.00	71.56	71.80	71.80	0.00	71.80	0.00
Aiea Stream	309+08	USACE100yr	3850	55.95	68.00	71.56	68.38	68.38	0.00	68.38	0.00
Aiea Stream	308+89	USACE100yr	3850	55.45	66.42	71.56	66.11	66.11	0.00	66.11	0.00
Aiea Stream	308+69	USACE100yr	3850	54.64	63.64	71.56	63.28	63.28	0.00	63.28	0.00
Aiea Stream	308+54	USACE100yr	3850	53.98	60.90	71.56	58.85	58.85	0.00	58.85	0.00
Aiea Stream	308+42	USACE100yr	3850	47.45	60.58	60.48	51.20	51.20	0.00	51.20	0.00
Aiea Stream	308+41		Culvert						0.00		0.00
Aiea Stream	306+62	USACE100yr	3850	45.70	57.64	60.00	59.05	58.36	-0.69	58.29	-0.76
Aiea Stream	306+46	USACE100yr	3850	44.78	57.97	58.00	58.43	58.02	-0.41	57.85	-0.58
Aiea Stream	306+29	USACE100yr	3850	41.50	57.93	62.00	58.23	57.76	-0.47	57.57	-0.66
Aiea Stream	306+09	USACE100yr	3850	45.04	59.90	62.18	57.14	56.32	-0.82	56.22	-0.92
Aiea Stream	305+79	USACE100yr	3850	43.94	58.80	59.99	56.50	56.08	-0.42	55.65	-0.85
Aiea Stream	305+51	USACE100yr	3850	43.74	57.99	61.99	53.90	53.54	-0.36	53.58	-0.32
Aiea Stream	305+23	USACE100yr	3850	42.18	58.00	59.98	52.28	51.15	-1.13	52.03	-0.25
Aiea Stream	304+92	USACE100yr	3850	39.37	58.17	58.09	50.96	50.48	-0.48	50.90	-0.06
Aiea Stream	304+84	USACE100yr	3850	38.00	58.00	58.05	50.99	50.36	-0.63	50.43	-0.56
Aiea Stream	304+64	USACE100yr	3850	38.44	58.02	57.80	49.76	49.59	-0.17	49.71	-0.05
Aiea Stream	304+44	USACE100yr	3850	38.98	48.21	56.10	48.68	48.22	-0.46	48.02	-0.66
Aiea Stream	304+21	USACE100yr	3850	37.88	46.67	54.00	48.51	48.28	-0.23	48.28	-0.23
Aiea Stream	303+93	USACE100yr	3850	36.07	46.36	55.00	47.93	47.93	0.00	47.93	0.00
Aiea Stream	303+59	USACE100yr	3850	34.42	44.21	53.95	47.17	47.17	0.00	47.17	0.00
Aiea Stream	303+19	USACE100yr	3850	32.80	42.83	50.15	45.82	45.82	0.00	45.82	0.00
Aiea Stream	302+92	USACE100yr	3850	31.98	41.74	48.20	45.21	45.21	0.00	45.21	0.00
Aiea Stream	302+50	USACE100yr	3850	29.80	40.81	45.50	43.78	43.78	0.00	43.78	0.00
Aiea Stream	302+10	USACE100yr	3850	30.40	40.07	43.27	42.47	42.47	0.00	42.47	0.00
Aiea Stream	301+78	USACE100yr	3850	29.98	39.79	43.21	41.78	41.78	0.00	41.78	0.00
Aiea Stream	301+49	USACE100yr	3850	29.92	36.86	44.19	41.67	41.67	0.00	41.67	0.00
Aiea Stream	301+22	USACE100yr	3850	29.85	37.33	44.56	41.57	41.57	0.00	41.57	0.00
Aiea Stream	300+95	USACE100yr	3850	28.31	35.42	44.40	41.29	41.29	0.00	41.29	0.00
Aiea Stream	300+68	USACE100yr	3850	26.00	34.44	43.24	41.19	41.19	0.00	41.19	0.00
Aiea Stream	300+42	USACE100yr	3850	25.80	32.00	42.75	41.17	41.17	0.00	41.17	0.00
Aiea Stream	300+16	USACE100yr	3850	26.54	33.39	42.75	40.81	40.81	0.00	40.81	0.00

APPENDIX 20

HEC-RAS Model Results Comparison for Channel Velocity

HEC-RAS Profile Channel Velocity Comparision: 2-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Chnl Existing	Vel Chnl Proposed n=0.03	Vel Chnl Diff n=0.03	Vel Chnl Proposed n=0.05	Vel Chnl Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	2yr	375	63.94	6.03	6.03	0.00	6.03	0
Aiea Stream	310+87	2yr	375	63.36	6.87	6.87	0.00	6.87	0
Aiea Stream	310+57	2yr	375	61.97	5.97	5.98	0.01	5.98	0.01
Aiea Stream	310+25	2yr	375	61.02	7.33	7.34	0.01	7.34	0.01
Aiea Stream	309+97	2yr	375	60	6.61	6.61	0.00	6.61	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	2yr	375	59	7.95	7.95	0.00	7.95	0
Aiea Stream	309+32	2yr	375	57	7.38	7.38	0.00	7.38	0
Aiea Stream	309+08	2yr	375	55.95	9.08	9.08	0.00	9.08	0
Aiea Stream	308+89	2yr	375	55.45	11.24	11.24	0.00	11.24	0
Aiea Stream	308+69	2yr	375	54.64	12.38	12.38	0.00	12.38	0
Aiea Stream	308+54	2yr	375	53.98	14.23	14.23	0.00	14.23	0
Aiea Stream	308+42	2yr	375	47.45	19.61	19.61	0.00	19.61	0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	2yr	375	45.7	3.97	4.21	0.24	4.21	0.24
Aiea Stream	306+46	2yr	375	44.78	4.32	4.65	0.33	4.65	0.33
Aiea Stream	306+29	2yr	375	41.5	2.84	2.93	0.09	2.93	0.09
Aiea Stream	306+09	2yr	375	45.04	6.66	6.27	-0.39	6.27	-0.39
Aiea Stream	305+79	2yr	375	43.94	5.91	5.91	0.00	5.91	0
Aiea Stream	305+51	2yr	375	43.74	7.05	6.70	-0.35	6.71	-0.34
Aiea Stream	305+23	2yr	375	42.18	7.55	7.80	0.25	7.79	0.24
Aiea Stream	304+92	2yr	375	39.37	5.71	5.83	0.12	5.84	0.13
Aiea Stream	304+84	2yr	375	38	4.47	5.04	0.57	5.05	0.58
Aiea Stream	304+64	2yr	375	38.44	5.41	5.36	-0.05	5.37	-0.04
Aiea Stream	304+44	2yr	375	38.98	6.99	6.67	-0.32	6.67	-0.32
Aiea Stream	304+21	2yr	375	37.88	7.08	7.31	0.23	7.31	0.23
Aiea Stream	303+93	2yr	375	36.07	7.28	7.28	0.00	7.28	0
Aiea Stream	303+59	2yr	375	34.42	7.22	7.22	0.00	7.22	0
Aiea Stream	303+19	2yr	375	32.8	6.37	6.37	0.00	6.37	0
Aiea Stream	302+92	2yr	375	31.98	7.79	7.79	0.00	7.79	0
Aiea Stream	302+50	2yr	375	29.8	5.04	5.04	0.00	5.04	0
Aiea Stream	302+10	2yr	375	30.4	5.28	5.28	0.00	5.28	0
Aiea Stream	301+78	2yr	375	29.98	4.67	4.67	0.00	4.67	0
Aiea Stream	301+49	2yr	375	29.92	5.43	5.43	0.00	5.43	0
Aiea Stream	301+22	2yr	375	29.85	6.49	6.49	0.00	6.49	0
Aiea Stream	300+95	2yr	375	28.31	6.23	6.23	0.00	6.23	0
Aiea Stream	300+68	2yr	375	26	3.88	3.88	0.00	3.88	0
Aiea Stream	300+42	2yr	375	25.8	3.86	3.86	0.00	3.86	0
Aiea Stream	300+16	2yr	375	26.54	4.31	4.31	0.00	4.31	0

HEC-RAS Profile Channel Velocity Comparision: 5-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Chnl Existing	Vel Chnl Proposed n=0.03	Vel Chnl Diff n=0.03	Vel Chnl Proposed n=0.05	Vel Chnl Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	5yr	669	63.94	7.82	7.82	0.00	7.82	0
Aiea Stream	310+87	5yr	669	63.36	8.48	8.47	-0.01	8.47	-0.01
Aiea Stream	310+57	5yr	669	61.97	7.81	7.78	-0.03	7.78	-0.03
Aiea Stream	310+25	5yr	669	61.02	8.4	8.53	0.13	8.53	0.13
Aiea Stream	309+97	5yr	669	60	6.79	6.79	0.00	6.79	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	5yr	669	59	9.33	9.33	0.00	9.33	0
Aiea Stream	309+32	5yr	669	57	8.74	8.74	0.00	8.74	0
Aiea Stream	309+08	5yr	669	55.95	10.8	10.80	0.00	10.8	0
Aiea Stream	308+89	5yr	669	55.45	13.29	13.29	0.00	13.29	0
Aiea Stream	308+69	5yr	669	54.64	14.99	14.99	0.00	14.99	0
Aiea Stream	308+54	5yr	669	53.98	17.21	17.21	0.00	17.21	0
Aiea Stream	308+42	5yr	669	47.45	22.45	22.45	0.00	22.45	0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	5yr	669	45.7	4.77	5.05	0.28	5.04	0.27
Aiea Stream	306+46	5yr	669	44.78	5.19	5.45	0.26	5.47	0.28
Aiea Stream	306+29	5yr	669	41.5	3.99	4.11	0.12	4.11	0.12
Aiea Stream	306+09	5yr	669	45.04	8.25	7.80	-0.45	7.81	-0.44
Aiea Stream	305+79	5yr	669	43.94	7.28	7.31	0.03	7.32	0.04
Aiea Stream	305+51	5yr	669	43.74	9.34	8.64	-0.70	8.69	-0.65
Aiea Stream	305+23	5yr	669	42.18	8.88	9.26	0.38	9.26	0.38
Aiea Stream	304+92	5yr	669	39.37	7.11	7.26	0.15	7.29	0.18
Aiea Stream	304+84	5yr	669	38	5.92	6.65	0.73	6.71	0.79
Aiea Stream	304+64	5yr	669	38.44	7.11	7.03	-0.08	7.09	-0.02
Aiea Stream	304+44	5yr	669	38.98	9.1	8.31	-0.79	8.31	-0.79
Aiea Stream	304+21	5yr	669	37.88	8.96	9.43	0.47	9.43	0.47
Aiea Stream	303+93	5yr	669	36.07	8.39	8.39	0.00	8.39	0
Aiea Stream	303+59	5yr	669	34.42	8.2	8.20	0.00	8.2	0
Aiea Stream	303+19	5yr	669	32.8	7.82	7.82	0.00	7.82	0
Aiea Stream	302+92	5yr	669	31.98	9.63	9.63	0.00	9.63	0
Aiea Stream	302+50	5yr	669	29.8	6.71	6.71	0.00	6.71	0
Aiea Stream	302+10	5yr	669	30.4	6.81	6.81	0.00	6.81	0
Aiea Stream	301+78	5yr	669	29.98	6.05	6.05	0.00	6.05	0
Aiea Stream	301+49	5yr	669	29.92	6.83	6.83	0.00	6.83	0
Aiea Stream	301+22	5yr	669	29.85	7.54	7.54	0.00	7.54	0
Aiea Stream	300+95	5yr	669	28.31	6.95	6.95	0.00	6.95	0
Aiea Stream	300+68	5yr	669	26	4.88	4.88	0.00	4.88	0
Aiea Stream	300+42	5yr	669	25.8	4.79	4.79	0.00	4.79	0
Aiea Stream	300+16	5yr	669	26.54	5.31	5.31	0.00	5.31	0

HEC-RAS Profile Channel Velocity Comparision: 10-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Chnl Existing	Vel Chnl Proposed n=0.03	Vel Chnl Diff n=0.03	Vel Chnl Proposed n=0.05	Vel Chnl Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	10yr	919	63.94	9.04	9.04	0	9.04	0
Aiea Stream	310+87	10yr	919	63.36	9.55	9.54	-0.01	9.54	-0.01
Aiea Stream	310+57	10yr	919	61.97	9.1	9.07	-0.03	9.07	-0.03
Aiea Stream	310+25	10yr	919	61.02	8.93	9.09	0.16	9.09	0.16
Aiea Stream	309+97	10yr	919	60	7.12	7.12	0	7.12	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	10yr	919	59	9.7	9.70	0	9.7	0
Aiea Stream	309+32	10yr	919	57	9.57	9.57	0	9.57	0
Aiea Stream	309+08	10yr	919	55.95	11.9	11.90	0	11.9	0
Aiea Stream	308+89	10yr	919	55.45	14.36	14.36	0	14.36	0
Aiea Stream	308+69	10yr	919	54.64	16.47	16.47	0	16.47	0
Aiea Stream	308+54	10yr	919	53.98	18.96	18.96	0	18.96	0
Aiea Stream	308+42	10yr	919	47.45	24.1	24.10	0	24.1	0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	10yr	919	45.7	5.31	5.61	0.3	5.59	0.28
Aiea Stream	306+46	10yr	919	44.78	5.79	5.99	0.2	6.04	0.25
Aiea Stream	306+29	10yr	919	41.5	4.77	4.90	0.13	4.9	0.13
Aiea Stream	306+09	10yr	919	45.04	9.14	8.71	-0.43	8.74	-0.4
Aiea Stream	305+79	10yr	919	43.94	8.07	8.12	0.05	8.18	0.11
Aiea Stream	305+51	10yr	919	43.74	10.84	9.98	-0.86	10.06	-0.78
Aiea Stream	305+23	10yr	919	42.18	9.68	10.18	0.5	10.2	0.52
Aiea Stream	304+92	10yr	919	39.37	8.02	8.25	0.23	8.31	0.29
Aiea Stream	304+84	10yr	919	38	6.88	7.73	0.85	7.84	0.96
Aiea Stream	304+64	10yr	919	38.44	8.2	8.16	-0.04	8.29	0.09
Aiea Stream	304+44	10yr	919	38.98	10.6	9.33	-1.27	9.33	-1.27
Aiea Stream	304+21	10yr	919	37.88	9.93	10.67	0.74	10.67	0.74
Aiea Stream	303+93	10yr	919	36.07	8.78	8.78	0	8.78	0
Aiea Stream	303+59	10yr	919	34.42	8.78	8.78	0	8.78	0
Aiea Stream	303+19	10yr	919	32.8	8.76	8.76	0	8.76	0
Aiea Stream	302+92	10yr	919	31.98	10.78	10.78	0	10.78	0
Aiea Stream	302+50	10yr	919	29.8	7.87	7.87	0	7.87	0
Aiea Stream	302+10	10yr	919	30.4	7.85	7.85	0	7.85	0
Aiea Stream	301+78	10yr	919	29.98	6.89	6.89	0	6.89	0
Aiea Stream	301+49	10yr	919	29.92	7.64	7.64	0	7.64	0
Aiea Stream	301+22	10yr	919	29.85	7.97	7.97	0	7.97	0
Aiea Stream	300+95	10yr	919	28.31	7.35	7.35	0	7.35	0
Aiea Stream	300+68	10yr	919	26	5.66	5.66	0	5.66	0
Aiea Stream	300+42	10yr	919	25.8	5.07	5.07	0	5.07	0
Aiea Stream	300+16	10yr	919	26.54	5.98	5.98	0	5.98	0

HEC-RAS Profile Channel Velocity Comparision: 25-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Chnl Existing	Vel Chnl Proposed n=0.03	Vel Chnl Diff n=0.03	Vel Chnl Proposed n=0.05	Vel Chnl Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	25yr	1916	63.94	12.58	12.58	0	12.58	0
Aiea Stream	310+87	25yr	1916	63.36	12.11	12.09	-0.02	12.09	-0.02
Aiea Stream	310+57	25yr	1916	61.97	11.54	11.50	-0.04	11.5	-0.04
Aiea Stream	310+25	25yr	1916	61.02	9.57	9.76	0.19	9.76	0.19
Aiea Stream	309+97	25yr	1916	60	7.96	7.96	0	7.96	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	25yr	1916	59	10.06	10.06	0	10.06	0
Aiea Stream	309+32	25yr	1916	57	12.14	12.14	0	12.14	0
Aiea Stream	309+08	25yr	1916	55.95	15.28	15.28	0	15.28	0
Aiea Stream	308+89	25yr	1916	55.45	17.85	17.85	0	17.85	0
Aiea Stream	308+69	25yr	1916	54.64	20.31	20.31	0	20.31	0
Aiea Stream	308+54	25yr	1916	53.98	23.41	23.41	0	23.41	0
Aiea Stream	308+42	25yr	1916	47.45	28.23	28.23	0	28.23	0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	25yr	1916	45.7	6.96	7.27	0.31	7.28	0.32
Aiea Stream	306+46	25yr	1916	44.78	7.66	7.64	-0.02	7.81	0.15
Aiea Stream	306+29	25yr	1916	41.5	7.1	7.22	0.12	7.28	0.18
Aiea Stream	306+09	25yr	1916	45.04	11.24	10.78	-0.46	11.03	-0.21
Aiea Stream	305+79	25yr	1916	43.94	10.25	9.98	-0.27	10.33	0.08
Aiea Stream	305+51	25yr	1916	43.74	13.81	13.04	-0.77	13.37	-0.44
Aiea Stream	305+23	25yr	1916	42.18	12.06	12.81	0.75	12.88	0.82
Aiea Stream	304+92	25yr	1916	39.37	11	11.35	0.35	11.47	0.47
Aiea Stream	304+84	25yr	1916	38	9.95	10.94	0.99	11.31	1.36
Aiea Stream	304+64	25yr	1916	38.44	11.7	11.89	0.19	12.58	0.88
Aiea Stream	304+44	25yr	1916	38.98	13.38	12.76	-0.62	12.76	-0.62
Aiea Stream	304+21	25yr	1916	37.88	11.18	12.57	1.39	12.57	1.39
Aiea Stream	303+93	25yr	1916	36.07	9.57	9.57	0	9.57	0
Aiea Stream	303+59	25yr	1916	34.42	10.54	10.54	0	10.54	0
Aiea Stream	303+19	25yr	1916	32.8	11.39	11.39	0	11.39	0
Aiea Stream	302+92	25yr	1916	31.98	13.86	13.86	0	13.86	0
Aiea Stream	302+50	25yr	1916	29.8	11.63	11.63	0	11.63	0
Aiea Stream	302+10	25yr	1916	30.4	11.45	11.45	0	11.45	0
Aiea Stream	301+78	25yr	1916	29.98	9.51	9.51	0	9.51	0
Aiea Stream	301+49	25yr	1916	29.92	9.22	9.22	0	9.22	0
Aiea Stream	301+22	25yr	1916	29.85	10.24	10.24	0	10.24	0
Aiea Stream	300+95	25yr	1916	28.31	8.75	8.75	0	8.75	0
Aiea Stream	300+68	25yr	1916	26	6.91	6.91	0	6.91	0
Aiea Stream	300+42	25yr	1916	25.8	6.04	6.04	0	6.04	0
Aiea Stream	300+16	25yr	1916	26.54	7.44	7.44	0	7.44	0

HEC-RAS Profile Channel Velocity Comparision: 50-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Chnl Existing	Vel Chnl Proposed n=0.03	Vel Chnl Diff n=0.03	Vel Chnl Proposed n=0.05	Vel Chnl Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	50yr	2321	63.94	13.5	13.49	-0.01	13.49	-0.01
Aiea Stream	310+87	50yr	2321	63.36	12.52	12.50	-0.02	12.5	-0.02
Aiea Stream	310+57	50yr	2321	61.97	11.8	11.77	-0.03	11.77	-0.03
Aiea Stream	310+25	50yr	2321	61.02	9.57	9.77	0.2	9.77	0.2
Aiea Stream	309+97	50yr	2321	60	8.12	8.12	0	8.12	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	50yr	2321	59	10.3	10.30	0	10.3	0
Aiea Stream	309+32	50yr	2321	57	12.97	12.97	0	12.97	0
Aiea Stream	309+08	50yr	2321	55.95	16.34	16.34	0	16.34	0
Aiea Stream	308+89	50yr	2321	55.45	19.01	19.01	0	19.01	0
Aiea Stream	308+69	50yr	2321	54.64	21.6	21.60	0	21.6	0
Aiea Stream	308+54	50yr	2321	53.98	24.72	24.72	0	24.72	0
Aiea Stream	308+42	50yr	2321	47.45	29.43	29.43	0	29.43	0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	50yr	2321	45.7	7.51	7.82	0.31	7.86	0.35
Aiea Stream	306+46	50yr	2321	44.78	8.29	8.19	-0.1	8.43	0.14
Aiea Stream	306+29	50yr	2321	41.5	7.88	7.96	0.08	8.07	0.19
Aiea Stream	306+09	50yr	2321	45.04	11.8	11.33	-0.47	11.71	-0.09
Aiea Stream	305+79	50yr	2321	43.94	10.92	10.51	-0.41	11.03	0.11
Aiea Stream	305+51	50yr	2321	43.74	14.61	13.62	-0.99	14.08	-0.53
Aiea Stream	305+23	50yr	2321	42.18	12.87	14.46	1.59	13.6	0.73
Aiea Stream	304+92	50yr	2321	39.37	12.07	12.33	0.26	12.36	0.29
Aiea Stream	304+84	50yr	2321	38	11.04	11.93	0.89	12.29	1.25
Aiea Stream	304+64	50yr	2321	38.44	12.98	13.32	0.34	13.82	0.84
Aiea Stream	304+44	50yr	2321	38.98	14.18	13.41	-0.77	13.41	-0.77
Aiea Stream	304+21	50yr	2321	37.88	11.52	12.96	1.44	12.96	1.44
Aiea Stream	303+93	50yr	2321	36.07	10.03	10.03	0	10.03	0
Aiea Stream	303+59	50yr	2321	34.42	11.27	11.27	0	11.27	0
Aiea Stream	303+19	50yr	2321	32.8	12.11	12.11	0	12.11	0
Aiea Stream	302+92	50yr	2321	31.98	14.68	14.68	0	14.68	0
Aiea Stream	302+50	50yr	2321	29.8	13.07	13.07	0	13.07	0
Aiea Stream	302+10	50yr	2321	30.4	13.03	13.03	0	13.03	0
Aiea Stream	301+78	50yr	2321	29.98	10.72	10.72	0	10.72	0
Aiea Stream	301+49	50yr	2321	29.92	10.01	10.01	0	10.01	0
Aiea Stream	301+22	50yr	2321	29.85	10.16	10.16	0	10.16	0
Aiea Stream	300+95	50yr	2321	28.31	8.97	8.97	0	8.97	0
Aiea Stream	300+68	50yr	2321	26	7.35	7.35	0	7.35	0
Aiea Stream	300+42	50yr	2321	25.8	6.48	6.48	0	6.48	0
Aiea Stream	300+16	50yr	2321	26.54	7.84	7.84	0	7.84	0

HEC-RAS Profile Channel Velocity Comparision: 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Chnl Existing	Vel Chnl Proposed n=0.03	Vel Chnl Diff n=0.03	Vel Chnl Proposed n=0.05	Vel Chnl Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	100yr	2743	63.94	14.15	14.13	-0.02	14.13	-0.02
Aiea Stream	310+87	100yr	2743	63.36	12.7	12.69	-0.01	12.69	-0.01
Aiea Stream	310+57	100yr	2743	61.97	11.91	11.88	-0.03	11.88	-0.03
Aiea Stream	310+25	100yr	2743	61.02	9.56	9.75	0.19	9.75	0.19
Aiea Stream	309+97	100yr	2743	60	8.25	8.25	0	8.25	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	100yr	2743	59	10.62	10.62	0	10.62	0
Aiea Stream	309+32	100yr	2743	57	13.61	13.61	0	13.61	0
Aiea Stream	309+08	100yr	2743	55.95	17.31	17.31	0	17.31	0
Aiea Stream	308+89	100yr	2743	55.45	20.09	20.09	0	20.09	0
Aiea Stream	308+69	100yr	2743	54.64	22.82	22.82	0	22.82	0
Aiea Stream	308+54	100yr	2743	53.98	25.93	25.93	0	25.93	0
Aiea Stream	308+42	100yr	2743	47.45	30.54	30.54	0	30.54	0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	100yr	2743	45.7	8.03	8.34	0.31	8.42	0.39
Aiea Stream	306+46	100yr	2743	44.78	8.9	8.72	-0.18	9.03	0.13
Aiea Stream	306+29	100yr	2743	41.5	8.62	8.67	0.05	8.84	0.22
Aiea Stream	306+09	100yr	2743	45.04	12.29	11.82	-0.47	12.34	0.05
Aiea Stream	305+79	100yr	2743	43.94	11.56	10.99	-0.57	11.69	0.13
Aiea Stream	305+51	100yr	2743	43.74	15.31	14.12	-1.19	14.71	-0.6
Aiea Stream	305+23	100yr	2743	42.18	13.63	15.33	1.7	14.24	0.61
Aiea Stream	304+92	100yr	2743	39.37	13.09	13.20	0.11	13.19	0.1
Aiea Stream	304+84	100yr	2743	38	12.11	12.78	0.67	13.18	1.07
Aiea Stream	304+64	100yr	2743	38.44	14.55	14.36	-0.19	15.01	0.46
Aiea Stream	304+44	100yr	2743	38.98	14.66	14.03	-0.63	14.03	-0.63
Aiea Stream	304+21	100yr	2743	37.88	12.06	13.54	1.48	13.54	1.48
Aiea Stream	303+93	100yr	2743	36.07	10.7	10.70	0	10.7	0
Aiea Stream	303+59	100yr	2743	34.42	12.05	12.05	0	12.05	0
Aiea Stream	303+19	100yr	2743	32.8	13.07	13.07	0	13.07	0
Aiea Stream	302+92	100yr	2743	31.98	15.01	15.01	0	15.01	0
Aiea Stream	302+50	100yr	2743	29.8	14.05	14.05	0	14.05	0
Aiea Stream	302+10	100yr	2743	30.4	14.44	14.44	0	14.44	0
Aiea Stream	301+78	100yr	2743	29.98	11.73	11.73	0	11.73	0
Aiea Stream	301+49	100yr	2743	29.92	10.41	10.41	0	10.41	0
Aiea Stream	301+22	100yr	2743	29.85	10.08	10.08	0	10.08	0
Aiea Stream	300+95	100yr	2743	28.31	9.21	9.21	0	9.21	0
Aiea Stream	300+68	100yr	2743	26	7.76	7.76	0	7.76	0
Aiea Stream	300+42	100yr	2743	25.8	6.9	6.90	0	6.9	0
Aiea Stream	300+16	100yr	2743	26.54	8.22	8.22	0	8.22	0

HEC-RAS Profile Channel Velocity Comparision: USACE 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Chnl Existing	Vel Chnl Proposed n=0.03	Vel Chnl Diff n=0.03	Vel Chnl Proposed n=0.05	Vel Chnl Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	USACE100yr	3850	63.94	13	13.00	0	13	0
Aiea Stream	310+87	USACE100yr	3850	63.36	11.29	11.29	0	11.29	0
Aiea Stream	310+57	USACE100yr	3850	61.97	10.68	10.67	-0.01	10.67	-0.01
Aiea Stream	310+25	USACE100yr	3850	61.02	8.46	8.62	0.16	8.62	0.16
Aiea Stream	309+97	USACE100yr	3850	60	7.66	7.66	0	7.66	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	USACE100yr	3850	59	11.38	11.38	0	11.38	0
Aiea Stream	309+32	USACE100yr	3850	57	13.67	13.67	0	13.67	0
Aiea Stream	309+08	USACE100yr	3850	55.95	19.22	19.22	0	19.22	0
Aiea Stream	308+89	USACE100yr	3850	55.45	22.46	22.46	0	22.46	0
Aiea Stream	308+69	USACE100yr	3850	54.64	25.52	25.52	0	25.52	0
Aiea Stream	308+54	USACE100yr	3850	53.98	28.61	28.61	0	28.61	0
Aiea Stream	308+42	USACE100yr	3850	47.45	33.01	33.01	0	33.01	0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	USACE100yr	3850	45.7	9.21	9.52	0.31	9.71	0.5
Aiea Stream	306+46	USACE100yr	3850	44.78	10.28	9.88	-0.4	10.4	0.12
Aiea Stream	306+29	USACE100yr	3850	41.5	10.37	10.27	-0.1	10.65	0.28
Aiea Stream	306+09	USACE100yr	3850	45.04	13.4	12.84	-0.56	13.77	0.37
Aiea Stream	305+79	USACE100yr	3850	43.94	12.99	12.02	-0.97	13.23	0.24
Aiea Stream	305+51	USACE100yr	3850	43.74	16.95	15.16	-1.79	16.1	-0.85
Aiea Stream	305+23	USACE100yr	3850	42.18	15.18	17.05	1.87	15.81	0.63
Aiea Stream	304+92	USACE100yr	3850	39.37	15.55	15.67	0.12	15.44	-0.11
Aiea Stream	304+84	USACE100yr	3850	38	14.65	15.18	0.53	15.95	1.3
Aiea Stream	304+64	USACE100yr	3850	38.44	16.69	16.07	-0.62	16.56	-0.13
Aiea Stream	304+44	USACE100yr	3850	38.98	17.26	17.34	0.08	17.88	0.62
Aiea Stream	304+21	USACE100yr	3850	37.88	12.93	14.40	1.47	14.4	1.47
Aiea Stream	303+93	USACE100yr	3850	36.07	12.37	12.37	0	12.37	0
Aiea Stream	303+59	USACE100yr	3850	34.42	13.78	13.78	0	13.78	0
Aiea Stream	303+19	USACE100yr	3850	32.8	15.51	15.51	0	15.51	0
Aiea Stream	302+92	USACE100yr	3850	31.98	16.03	16.03	0	16.03	0
Aiea Stream	302+50	USACE100yr	3850	29.8	15.46	15.46	0	15.46	0
Aiea Stream	302+10	USACE100yr	3850	30.4	15.47	15.48	0.01	15.47	0
Aiea Stream	301+78	USACE100yr	3850	29.98	12.5	12.50	0	12.5	0
Aiea Stream	301+49	USACE100yr	3850	29.92	11.13	11.13	0	11.13	0
Aiea Stream	301+22	USACE100yr	3850	29.85	10.09	10.09	0	10.09	0
Aiea Stream	300+95	USACE100yr	3850	28.31	9.82	9.82	0	9.82	0
Aiea Stream	300+68	USACE100yr	3850	26	8.67	8.67	0	8.67	0
Aiea Stream	300+42	USACE100yr	3850	25.8	7.83	7.83	0	7.83	0
Aiea Stream	300+16	USACE100yr	3850	26.54	9.06	9.06	0	9.06	0

APPENDIX 21

HEC-RAS Model Results Comparison for Left Bank Velocity (Looking Downstream)

HEC-RAS Profile Left Bank Velocity Comparision: 2-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Left Existing	Vel Left Proposed n=0.03	Vel Left Diff n=0.03	Vel Left Proposed n=0.05	Vel Left Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	2yr	375	63.94	0.02	0.02	0	0.02	0
Aiea Stream	310+87	2yr	375	63.36			0		0
Aiea Stream	310+57	2yr	375	61.97	0.41	0.41	0	0.41	0
Aiea Stream	310+25	2yr	375	61.02			0		0
Aiea Stream	309+97	2yr	375	60			0		0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	2yr	375	59			0		0
Aiea Stream	309+32	2yr	375	57			0		0
Aiea Stream	309+08	2yr	375	55.95	0.04	0.04	0	0.04	0
Aiea Stream	308+89	2yr	375	55.45	0.3	0.3	0	0.3	0
Aiea Stream	308+69	2yr	375	54.64	0.15	0.15	0	0.15	0
Aiea Stream	308+54	2yr	375	53.98			0		0
Aiea Stream	308+42	2yr	375	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	2yr	375	45.7	0.06	0.06	0	0.06	0
Aiea Stream	306+46	2yr	375	44.78	0.14	0.14	0	0.14	0
Aiea Stream	306+29	2yr	375	41.5	0.18	0.16	-0.02	0.16	-0.02
Aiea Stream	306+09	2yr	375	45.04	0.93	0.77	-0.16	0.77	-0.16
Aiea Stream	305+79	2yr	375	43.94	0.58	0.54	-0.04	0.54	-0.04
Aiea Stream	305+51	2yr	375	43.74	0.55	0.53	-0.02	0.53	-0.02
Aiea Stream	305+23	2yr	375	42.18	0.33	0.34	0.01	0.34	0.01
Aiea Stream	304+92	2yr	375	39.37	1.24	1.22	-0.02	1.22	-0.02
Aiea Stream	304+84	2yr	375	38	0.32	0.35	0.03	0.35	0.03
Aiea Stream	304+64	2yr	375	38.44	0.88	0.84	-0.04	0.84	-0.04
Aiea Stream	304+44	2yr	375	38.98	0.81	0.78	-0.03	0.78	-0.03
Aiea Stream	304+21	2yr	375	37.88	0.87	0.88	0.01	0.88	0.01
Aiea Stream	303+93	2yr	375	36.07	0.98	0.98	0	0.98	0
Aiea Stream	303+59	2yr	375	34.42			0		0
Aiea Stream	303+19	2yr	375	32.8	0.07	0.07	0	0.07	0
Aiea Stream	302+92	2yr	375	31.98	0.52	0.52	0	0.52	0
Aiea Stream	302+50	2yr	375	29.8	0.08	0.08	0	0.08	0
Aiea Stream	302+10	2yr	375	30.4	0.12	0.12	0	0.12	0
Aiea Stream	301+78	2yr	375	29.98	0.06	0.06	0	0.06	0
Aiea Stream	301+49	2yr	375	29.92	0.67	0.67	0	0.67	0
Aiea Stream	301+22	2yr	375	29.85	1.61	1.61	0	1.61	0
Aiea Stream	300+95	2yr	375	28.31	1.33	1.33	0	1.33	0
Aiea Stream	300+68	2yr	375	26	0.93	0.93	0	0.93	0
Aiea Stream	300+42	2yr	375	25.8	0.88	0.88	0	0.88	0
Aiea Stream	300+16	2yr	375	26.54	1.18	1.18	0	1.18	0

HEC-RAS Profile Left Bank Velocity Comparision: 5-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Left Existing	Vel Left Proposed n=0.03	Vel Left Diff n=0.03	Vel Left Proposed n=0.05	Vel Left Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	5yr	669	63.94	0.05	0.05	0	0.05	0
Aiea Stream	310+87	5yr	669	63.36	0.91	0.91	0	0.91	0
Aiea Stream	310+57	5yr	669	61.97	0.9	0.9	0	0.9	0
Aiea Stream	310+25	5yr	669	61.02	0.67	0.65	-0.02	0.65	-0.02
Aiea Stream	309+97	5yr	669	60	0.84	0.84	0	0.84	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	5yr	669	59	1.03	1.03	0	1.03	0
Aiea Stream	309+32	5yr	669	57	0.09	0.09	0	0.09	0
Aiea Stream	309+08	5yr	669	55.95	0.44	0.44	0	0.44	0
Aiea Stream	308+89	5yr	669	55.45	0.71	0.71	0	0.71	0
Aiea Stream	308+69	5yr	669	54.64	0.7	0.7	0	0.7	0
Aiea Stream	308+54	5yr	669	53.98			0		0
Aiea Stream	308+42	5yr	669	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	5yr	669	45.7	0.09	0.09	0	0.09	0
Aiea Stream	306+46	5yr	669	44.78	0.22	0.23	0.01	0.23	0.01
Aiea Stream	306+29	5yr	669	41.5	0.37	0.36	-0.01	0.36	-0.01
Aiea Stream	306+09	5yr	669	45.04	1.67	1.5	-0.17	1.51	-0.16
Aiea Stream	305+79	5yr	669	43.94	1	0.96	-0.04	0.96	-0.04
Aiea Stream	305+51	5yr	669	43.74	1.08	1.02	-0.06	1.02	-0.06
Aiea Stream	305+23	5yr	669	42.18	0.92	0.96	0.04	0.96	0.04
Aiea Stream	304+92	5yr	669	39.37	2.04	2.05	0.01	2.06	0.02
Aiea Stream	304+84	5yr	669	38	0.6	0.66	0.06	0.66	0.06
Aiea Stream	304+64	5yr	669	38.44	1.52	1.48	-0.04	1.49	-0.03
Aiea Stream	304+44	5yr	669	38.98	1.33	1.25	-0.08	1.25	-0.08
Aiea Stream	304+21	5yr	669	37.88	1.57	1.65	0.08	1.65	0.08
Aiea Stream	303+93	5yr	669	36.07	1.49	1.49	0	1.49	0
Aiea Stream	303+59	5yr	669	34.42	0.02	0.02	0	0.02	0
Aiea Stream	303+19	5yr	669	32.8	0.12	0.12	0	0.12	0
Aiea Stream	302+92	5yr	669	31.98	0.79	0.79	0	0.79	0
Aiea Stream	302+50	5yr	669	29.8	0.13	0.13	0	0.13	0
Aiea Stream	302+10	5yr	669	30.4	0.2	0.2	0	0.2	0
Aiea Stream	301+78	5yr	669	29.98	0.1	0.1	0	0.1	0
Aiea Stream	301+49	5yr	669	29.92	1.11	1.11	0	1.11	0
Aiea Stream	301+22	5yr	669	29.85	2.23	2.23	0	2.23	0
Aiea Stream	300+95	5yr	669	28.31	1.9	1.9	0	1.9	0
Aiea Stream	300+68	5yr	669	26	1.36	1.36	0	1.36	0
Aiea Stream	300+42	5yr	669	25.8	0.81	0.81	0	0.81	0
Aiea Stream	300+16	5yr	669	26.54	1.53	1.53	0	1.53	0

HEC-RAS Profile Left Bank Velocity Comparision: 10-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Left Existing	Vel Left Proposed n=0.03	Vel Left Diff n=0.03	Vel Left Proposed n=0.05	Vel Left Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	10yr	919	63.94	0.07	0.07	0	0.07	0
Aiea Stream	310+87	10yr	919	63.36	1.34	1.34	0	1.34	0
Aiea Stream	310+57	10yr	919	61.97	1.19	1.19	0	1.19	0
Aiea Stream	310+25	10yr	919	61.02	1.23	1.22	-0.01	1.22	-0.01
Aiea Stream	309+97	10yr	919	60	1.12	1.12	0	1.12	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	10yr	919	59	1.42	1.42	0	1.42	0
Aiea Stream	309+32	10yr	919	57	0.12	0.12	0	0.12	0
Aiea Stream	309+08	10yr	919	55.95	0.6	0.6	0	0.6	0
Aiea Stream	308+89	10yr	919	55.45	0.9	0.9	0	0.9	0
Aiea Stream	308+69	10yr	919	54.64	0.95	0.95	0	0.95	0
Aiea Stream	308+54	10yr	919	53.98			0		0
Aiea Stream	308+42	10yr	919	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	10yr	919	45.7	0.1	0.11	0.01	0.11	0.01
Aiea Stream	306+46	10yr	919	44.78	0.27	0.28	0.01	0.28	0.01
Aiea Stream	306+29	10yr	919	41.5	0.5	0.49	-0.01	0.49	-0.01
Aiea Stream	306+09	10yr	919	45.04	2.06	1.89	-0.17	1.9	-0.16
Aiea Stream	305+79	10yr	919	43.94	1.23	1.2	-0.03	1.21	-0.02
Aiea Stream	305+51	10yr	919	43.74	1.39	1.29	-0.1	1.31	-0.08
Aiea Stream	305+23	10yr	919	42.18	1.19	1.24	0.05	1.24	0.05
Aiea Stream	304+92	10yr	919	39.37	2.51	2.54	0.03	2.56	0.05
Aiea Stream	304+84	10yr	919	38	0.77	0.85	0.08	0.87	0.1
Aiea Stream	304+64	10yr	919	38.44	1.92	1.88	-0.04	1.91	-0.01
Aiea Stream	304+44	10yr	919	38.98	1.71	1.6	-0.11	1.6	-0.11
Aiea Stream	304+21	10yr	919	37.88	1.97	2.11	0.14	2.11	0.14
Aiea Stream	303+93	10yr	919	36.07	1.68	1.68	0	1.68	0
Aiea Stream	303+59	10yr	919	34.42	0.02	0.02	0	0.02	0
Aiea Stream	303+19	10yr	919	32.8	0.14	0.14	0	0.14	0
Aiea Stream	302+92	10yr	919	31.98	0.95	0.95	0	0.95	0
Aiea Stream	302+50	10yr	919	29.8	0.17	0.17	0	0.17	0
Aiea Stream	302+10	10yr	919	30.4	0.25	0.25	0	0.25	0
Aiea Stream	301+78	10yr	919	29.98	0.39	0.39	0	0.39	0
Aiea Stream	301+49	10yr	919	29.92	1.35	1.35	0	1.35	0
Aiea Stream	301+22	10yr	919	29.85	2.56	2.56	0	2.56	0
Aiea Stream	300+95	10yr	919	28.31	2.22	2.22	0	2.22	0
Aiea Stream	300+68	10yr	919	26	0.63	0.63	0	0.63	0
Aiea Stream	300+42	10yr	919	25.8	0.97	0.97	0	0.97	0
Aiea Stream	300+16	10yr	919	26.54	1.16	1.16	0	1.16	0

HEC-RAS Profile Left Bank Velocity Comparision: 25-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Left Existing	Vel Left Proposed n=0.03	Vel Left Diff n=0.03	Vel Left Proposed n=0.05	Vel Left Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	25yr	1916	63.94	0.14	0.14	0	0.14	0
Aiea Stream	310+87	25yr	1916	63.36	2.31	2.31	0	2.31	0
Aiea Stream	310+57	25yr	1916	61.97	1.89	1.88	-0.01	1.88	-0.01
Aiea Stream	310+25	25yr	1916	61.02	2.06	2.08	0.02	2.08	0.02
Aiea Stream	309+97	25yr	1916	60	1.61	1.61	0	1.61	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	25yr	1916	59	1.97	1.97	0	1.97	0
Aiea Stream	309+32	25yr	1916	57	0.2	0.2	0	0.2	0
Aiea Stream	309+08	25yr	1916	55.95	0.98	0.98	0	0.98	0
Aiea Stream	308+89	25yr	1916	55.45	1.36	1.36	0	1.36	0
Aiea Stream	308+69	25yr	1916	54.64	1.51	1.51	0	1.51	0
Aiea Stream	308+54	25yr	1916	53.98	0.03	0.03	0	0.03	0
Aiea Stream	308+42	25yr	1916	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	25yr	1916	45.7	0.14	0.14	0	0.14	0
Aiea Stream	306+46	25yr	1916	44.78	0.4	0.4	0	0.41	0.01
Aiea Stream	306+29	25yr	1916	41.5	0.83	0.84	0.01	0.85	0.02
Aiea Stream	306+09	25yr	1916	45.04	2.93	2.76	-0.17	2.83	-0.1
Aiea Stream	305+79	25yr	1916	43.94	1.9	1.81	-0.09	1.87	-0.03
Aiea Stream	305+51	25yr	1916	43.74	2.2	2.07	-0.13	2.13	-0.07
Aiea Stream	305+23	25yr	1916	42.18	1.91	1.99	0.08	2.01	0.1
Aiea Stream	304+92	25yr	1916	39.37	3.86	3.94	0.08	3.99	0.13
Aiea Stream	304+84	25yr	1916	38	1.29	1.41	0.12	1.46	0.17
Aiea Stream	304+64	25yr	1916	38.44	2.89	2.89	0	3.03	0.14
Aiea Stream	304+44	25yr	1916	38.98	2.85	2.72	-0.13	2.72	-0.13
Aiea Stream	304+21	25yr	1916	37.88	2.66	2.99	0.33	2.99	0.33
Aiea Stream	303+93	25yr	1916	36.07	1.91	1.91	0	1.91	0
Aiea Stream	303+59	25yr	1916	34.42	0.03	0.03	0	0.03	0
Aiea Stream	303+19	25yr	1916	32.8	0.21	0.21	0	0.21	0
Aiea Stream	302+92	25yr	1916	31.98	1.36	1.36	0	1.36	0
Aiea Stream	302+50	25yr	1916	29.8	0.29	0.29	0	0.29	0
Aiea Stream	302+10	25yr	1916	30.4	0.41	0.41	0	0.41	0
Aiea Stream	301+78	25yr	1916	29.98	1.51	1.51	0	1.51	0
Aiea Stream	301+49	25yr	1916	29.92	1.44	1.44	0	1.44	0
Aiea Stream	301+22	25yr	1916	29.85	1.62	1.62	0	1.62	0
Aiea Stream	300+95	25yr	1916	28.31	2.04	2.04	0	2.04	0
Aiea Stream	300+68	25yr	1916	26	1.79	1.79	0	1.79	0
Aiea Stream	300+42	25yr	1916	25.8	1.86	1.86	0	1.86	0
Aiea Stream	300+16	25yr	1916	26.54	1.89	1.89	0	1.89	0

HEC-RAS Profile Left Bank Velocity Comparision: 50-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Left Existing	Vel Left Proposed n=0.03	Vel Left Diff n=0.03	Vel Left Proposed n=0.05	Vel Left Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	50yr	2321	63.94	0.16	0.16	0	0.16	0
Aiea Stream	310+87	50yr	2321	63.36	2.59	2.59	0	2.59	0
Aiea Stream	310+57	50yr	2321	61.97	2.01	2	-0.01	2	-0.01
Aiea Stream	310+25	50yr	2321	61.02	2.18	2.21	0.03	2.21	0.03
Aiea Stream	309+97	50yr	2321	60	1.7	1.7	0	1.7	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	50yr	2321	59	2.08	2.08	0	2.08	0
Aiea Stream	309+32	50yr	2321	57	0.5	0.5	0	0.5	0
Aiea Stream	309+08	50yr	2321	55.95	1.09	1.09	0	1.09	0
Aiea Stream	308+89	50yr	2321	55.45	1.5	1.5	0	1.5	0
Aiea Stream	308+69	50yr	2321	54.64	1.68	1.68	0	1.68	0
Aiea Stream	308+54	50yr	2321	53.98	0.03	0.03	0	0.03	0
Aiea Stream	308+42	50yr	2321	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	50yr	2321	45.7	0.15	0.15	0	0.15	0
Aiea Stream	306+46	50yr	2321	44.78	0.45	0.44	-0.01	0.45	0
Aiea Stream	306+29	50yr	2321	41.5	0.92	0.93	0.01	0.95	0.03
Aiea Stream	306+09	50yr	2321	45.04	3.14	2.97	-0.17	3.07	-0.07
Aiea Stream	305+79	50yr	2321	43.94	2.09	1.98	-0.11	2.06	-0.03
Aiea Stream	305+51	50yr	2321	43.74	2.42	2.24	-0.18	2.32	-0.1
Aiea Stream	305+23	50yr	2321	42.18	2.22	2.33	0.11	2.31	0.09
Aiea Stream	304+92	50yr	2321	39.37	4.31	4.37	0.06	4.39	0.08
Aiea Stream	304+84	50yr	2321	38	1.47	1.58	0.11	1.63	0.16
Aiea Stream	304+64	50yr	2321	38.44	3.3	3.3	0	3.41	0.11
Aiea Stream	304+44	50yr	2321	38.98	3.21	3.05	-0.16	3.05	-0.16
Aiea Stream	304+21	50yr	2321	37.88	2.77	3.13	0.36	3.13	0.36
Aiea Stream	303+93	50yr	2321	36.07	1.99	1.99	0	1.99	0
Aiea Stream	303+59	50yr	2321	34.42	0.68	0.68	0	0.68	0
Aiea Stream	303+19	50yr	2321	32.8	1.16	1.16	0	1.16	0
Aiea Stream	302+92	50yr	2321	31.98	1.31	1.31	0	1.31	0
Aiea Stream	302+50	50yr	2321	29.8	0.44	0.44	0	0.44	0
Aiea Stream	302+10	50yr	2321	30.4	0.69	0.69	0	0.69	0
Aiea Stream	301+78	50yr	2321	29.98	1.78	1.78	0	1.78	0
Aiea Stream	301+49	50yr	2321	29.92	1.79	1.79	0	1.79	0
Aiea Stream	301+22	50yr	2321	29.85	2.32	2.32	0	2.32	0
Aiea Stream	300+95	50yr	2321	28.31	2.43	2.43	0	2.43	0
Aiea Stream	300+68	50yr	2321	26	2.1	2.1	0	2.1	0
Aiea Stream	300+42	50yr	2321	25.8	2.12	2.12	0	2.12	0
Aiea Stream	300+16	50yr	2321	26.54	2.22	2.22	0	2.22	0

HEC-RAS Profile Left Bank Velocity Comparision: 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Left Existing	Vel Left Proposed n=0.03	Vel Left Diff n=0.03	Vel Left Proposed n=0.05	Vel Left Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	100yr	2743	63.94	0.19	0.2	0.01	0.2	0.01
Aiea Stream	310+87	100yr	2743	63.36	2.78	2.78	0	2.78	0
Aiea Stream	310+57	100yr	2743	61.97	2.14	2.14	0	2.14	0
Aiea Stream	310+25	100yr	2743	61.02	2.27	2.3	0.03	2.3	0.03
Aiea Stream	309+97	100yr	2743	60	1.78	1.78	0	1.78	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	100yr	2743	59	2.1	2.1	0	2.1	0
Aiea Stream	309+32	100yr	2743	57	1.42	1.42	0	1.42	0
Aiea Stream	309+08	100yr	2743	55.95	1.19	1.19	0	1.19	0
Aiea Stream	308+89	100yr	2743	55.45	1.62	1.62	0	1.62	0
Aiea Stream	308+69	100yr	2743	54.64	1.82	1.82	0	1.82	0
Aiea Stream	308+54	100yr	2743	53.98	0.04	0.04	0	0.04	0
Aiea Stream	308+42	100yr	2743	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	100yr	2743	45.7	0.18	0.16	-0.02	0.17	-0.01
Aiea Stream	306+46	100yr	2743	44.78	0.49	0.47	-0.02	0.49	0
Aiea Stream	306+29	100yr	2743	41.5	1	1.01	0.01	1.03	0.03
Aiea Stream	306+09	100yr	2743	45.04	3.3	3.15	-0.15	3.29	-0.01
Aiea Stream	305+79	100yr	2743	43.94	2.26	2.12	-0.14	2.24	-0.02
Aiea Stream	305+51	100yr	2743	43.74	2.68	2.44	-0.24	2.55	-0.13
Aiea Stream	305+23	100yr	2743	42.18	2.51	2.64	0.13	2.61	0.1
Aiea Stream	304+92	100yr	2743	39.37	4.75	4.75	0	4.77	0.02
Aiea Stream	304+84	100yr	2743	38	1.55	1.73	0.18	1.76	0.21
Aiea Stream	304+64	100yr	2743	38.44	3.77	3.67	-0.1	3.82	0.05
Aiea Stream	304+44	100yr	2743	38.98	3.49	3.32	-0.17	3.32	-0.17
Aiea Stream	304+21	100yr	2743	37.88	2.92	3.3	0.38	3.3	0.38
Aiea Stream	303+93	100yr	2743	36.07	2.12	2.12	0	2.12	0
Aiea Stream	303+59	100yr	2743	34.42	1.45	1.45	0	1.45	0
Aiea Stream	303+19	100yr	2743	32.8	1.84	1.84	0	1.84	0
Aiea Stream	302+92	100yr	2743	31.98	2.45	2.45	0	2.45	0
Aiea Stream	302+50	100yr	2743	29.8	1.45	1.45	0	1.45	0
Aiea Stream	302+10	100yr	2743	30.4	1.06	1.06	0	1.06	0
Aiea Stream	301+78	100yr	2743	29.98	1.04	1.04	0	1.04	0
Aiea Stream	301+49	100yr	2743	29.92	2.09	2.09	0	2.09	0
Aiea Stream	301+22	100yr	2743	29.85	2.79	2.79	0	2.79	0
Aiea Stream	300+95	100yr	2743	28.31	2.75	2.75	0	2.75	0
Aiea Stream	300+68	100yr	2743	26	2.38	2.38	0	2.38	0
Aiea Stream	300+42	100yr	2743	25.8	2.36	2.36	0	2.36	0
Aiea Stream	300+16	100yr	2743	26.54	2.51	2.51	0	2.51	0

HEC-RAS Profile Left Bank Velocity Comparision: USACE 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Left Existing	Vel Left Proposed n=0.03	Vel Left Diff n=0.03	Vel Left Proposed n=0.05	Vel Left Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	USACE100yr	3850	63.94	0.61	0.61	0	0.61	0
Aiea Stream	310+87	USACE100yr	3850	63.36	2.71	2.71	0	2.71	0
Aiea Stream	310+57	USACE100yr	3850	61.97	2.08	2.08	0	2.08	0
Aiea Stream	310+25	USACE100yr	3850	61.02	2.16	2.19	0.03	2.19	0.03
Aiea Stream	309+97	USACE100yr	3850	60	1.73	1.73	0	1.73	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	USACE100yr	3850	59	2.33	2.33	0	2.33	0
Aiea Stream	309+32	USACE100yr	3850	57	3.21	3.21	0	3.21	0
Aiea Stream	309+08	USACE100yr	3850	55.95	1.19	1.19	0	1.19	0
Aiea Stream	308+89	USACE100yr	3850	55.45	1.85	1.85	0	1.85	0
Aiea Stream	308+69	USACE100yr	3850	54.64	2.09	2.09	0	2.09	0
Aiea Stream	308+54	USACE100yr	3850	53.98	0.04	0.04	0	0.04	0
Aiea Stream	308+42	USACE100yr	3850	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	USACE100yr	3850	45.7	0.53	0.39	-0.14	0.38	-0.15
Aiea Stream	306+46	USACE100yr	3850	44.78	0.53	0.54	0.01	0.58	0.05
Aiea Stream	306+29	USACE100yr	3850	41.5	0.8	1.17	0.37	1.22	0.42
Aiea Stream	306+09	USACE100yr	3850	45.04	3.4	3.38	-0.02	3.65	0.25
Aiea Stream	305+79	USACE100yr	3850	43.94	2.53	2.32	-0.21	2.55	0.02
Aiea Stream	305+51	USACE100yr	3850	43.74	3.22	2.87	-0.35	3.05	-0.17
Aiea Stream	305+23	USACE100yr	3850	42.18	3.16	3.33	0.17	3.27	0.11
Aiea Stream	304+92	USACE100yr	3850	39.37	5.66	5.71	0.05	5.62	-0.04
Aiea Stream	304+84	USACE100yr	3850	38	1.9	1.97	0.07	2.08	0.18
Aiea Stream	304+64	USACE100yr	3850	38.44	4.64	4.44	-0.2	4.6	-0.04
Aiea Stream	304+44	USACE100yr	3850	38.98	4.48	4.46	-0.02	4.53	0.05
Aiea Stream	304+21	USACE100yr	3850	37.88	3.28	3.62	0.34	3.62	0.34
Aiea Stream	303+93	USACE100yr	3850	36.07	1.69	1.69	0	1.69	0
Aiea Stream	303+59	USACE100yr	3850	34.42	2.74	2.74	0	2.74	0
Aiea Stream	303+19	USACE100yr	3850	32.8	3.11	3.11	0	3.11	0
Aiea Stream	302+92	USACE100yr	3850	31.98	4.03	4.03	0	4.03	0
Aiea Stream	302+50	USACE100yr	3850	29.8	3.34	3.34	0	3.34	0
Aiea Stream	302+10	USACE100yr	3850	30.4	3.39	3.39	0	3.39	0
Aiea Stream	301+78	USACE100yr	3850	29.98	2.85	2.85	0	2.85	0
Aiea Stream	301+49	USACE100yr	3850	29.92	2.67	2.67	0	2.67	0
Aiea Stream	301+22	USACE100yr	3850	29.85	3.55	3.55	0	3.55	0
Aiea Stream	300+95	USACE100yr	3850	28.31	3.39	3.39	0	3.39	0
Aiea Stream	300+68	USACE100yr	3850	26	2.99	2.99	0	2.99	0
Aiea Stream	300+42	USACE100yr	3850	25.8	2.9	2.9	0	2.9	0
Aiea Stream	300+16	USACE100yr	3850	26.54	3.13	3.13	0	3.13	0

APPENDIX 22

HEC-RAS Model Results Comparison for Right Bank Velocity (Looking Downstream)

HEC-RAS Profile Right Bank Velocity Comparision: 2-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Right Existing	Vel Right Proposed n=0.03	Vel Right Diff n=0.03	Vel Right Proposed n=0.05	Vel Right Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	2yr	375	63.94	0.52	0.52	0	0.52	0
Aiea Stream	310+87	2yr	375	63.36	0.12	0.12	0	0.12	0
Aiea Stream	310+57	2yr	375	61.97	0.46	0.46	0	0.46	0
Aiea Stream	310+25	2yr	375	61.02		0.2	0.2	0.2	0.2
Aiea Stream	309+97	2yr	375	60			0		0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	2yr	375	59			0		0
Aiea Stream	309+32	2yr	375	57			0		0
Aiea Stream	309+08	2yr	375	55.95			0		0
Aiea Stream	308+89	2yr	375	55.45	0.66	0.66	0	0.66	0
Aiea Stream	308+69	2yr	375	54.64	0.37	0.37	0	0.37	0
Aiea Stream	308+54	2yr	375	53.98			0		0
Aiea Stream	308+42	2yr	375	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	2yr	375	45.7	0.35	1.69	1.34	1.02	0.67
Aiea Stream	306+46	2yr	375	44.78	0.58	2.93	2.35	1.76	1.18
Aiea Stream	306+29	2yr	375	41.5	0.17	0.91	0.74	0.55	0.38
Aiea Stream	306+09	2yr	375	45.04	1.03	3.53	2.5	2.12	1.09
Aiea Stream	305+79	2yr	375	43.94	0.61	2.63	2.02	1.58	0.97
Aiea Stream	305+51	2yr	375	43.74	0.89	4.87	3.98	2.93	2.04
Aiea Stream	305+23	2yr	375	42.18	0.42	2.04	1.62	1.22	0.8
Aiea Stream	304+92	2yr	375	39.37	0.88	3.15	2.27	1.89	1.01
Aiea Stream	304+84	2yr	375	38	0.34	2.42	2.08	1.46	1.12
Aiea Stream	304+64	2yr	375	38.44	0.69	2.57	1.88	1.55	0.86
Aiea Stream	304+44	2yr	375	38.98	2.11	2.32	0.21	2.32	0.21
Aiea Stream	304+21	2yr	375	37.88	2.4	1.37	-1.03	1.37	-1.03
Aiea Stream	303+93	2yr	375	36.07	1.09	1.09	0	1.09	0
Aiea Stream	303+59	2yr	375	34.42	1.39	1.39	0	1.39	0
Aiea Stream	303+19	2yr	375	32.8	1.06	1.06	0	1.06	0
Aiea Stream	302+92	2yr	375	31.98	1.88	1.88	0	1.88	0
Aiea Stream	302+50	2yr	375	29.8	1	1	0	1	0
Aiea Stream	302+10	2yr	375	30.4	0.27	0.27	0	0.27	0
Aiea Stream	301+78	2yr	375	29.98	1.01	1.01	0	1.01	0
Aiea Stream	301+49	2yr	375	29.92	1.2	1.2	0	1.2	0
Aiea Stream	301+22	2yr	375	29.85	2.2	2.2	0	2.2	0
Aiea Stream	300+95	2yr	375	28.31	1.81	1.81	0	1.81	0
Aiea Stream	300+68	2yr	375	26	1.24	1.24	0	1.24	0
Aiea Stream	300+42	2yr	375	25.8	1.42	1.42	0	1.42	0
Aiea Stream	300+16	2yr	375	26.54	1.71	1.71	0	1.71	0

HEC-RAS Profile Right Bank Velocity Comparision: 5-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Right Existing	Vel Right Proposed n=0.03	Vel Right Diff n=0.03	Vel Right Proposed n=0.05	Vel Right Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	5yr	669	63.94	1.03	1.03	0	1.03	0
Aiea Stream	310+87	5yr	669	63.36	0.95	0.95	0	0.95	0
Aiea Stream	310+57	5yr	669	61.97	0.97	0.97	0	0.97	0
Aiea Stream	310+25	5yr	669	61.02	0.93	1.36	0.43	1.36	0.43
Aiea Stream	309+97	5yr	669	60	0.81	0.81	0	0.81	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	5yr	669	59	0.64	0.64	0	0.64	0
Aiea Stream	309+32	5yr	669	57	3.96	3.96	0	3.96	0
Aiea Stream	309+08	5yr	669	55.95	0.83	0.83	0	0.83	0
Aiea Stream	308+89	5yr	669	55.45	1.59	1.59	0	1.59	0
Aiea Stream	308+69	5yr	669	54.64	1.43	1.43	0	1.43	0
Aiea Stream	308+54	5yr	669	53.98	0.83	0.83	0	0.83	0
Aiea Stream	308+42	5yr	669	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	5yr	669	45.7	0.55	2.72	2.17	1.63	1.08
Aiea Stream	306+46	5yr	669	44.78	0.91	4.68	3.77	2.83	1.92
Aiea Stream	306+29	5yr	669	41.5	0.35	2.01	1.66	1.21	0.86
Aiea Stream	306+09	5yr	669	45.04	1.79	6.87	5.08	4.14	2.35
Aiea Stream	305+79	5yr	669	43.94	0.95	4.72	3.77	2.84	1.89
Aiea Stream	305+51	5yr	669	43.74	1.42	8.24	6.82	4.98	3.56
Aiea Stream	305+23	5yr	669	42.18	1.35	6.79	5.44	4.08	2.73
Aiea Stream	304+92	5yr	669	39.37	1.46	5.34	3.88	3.22	1.76
Aiea Stream	304+84	5yr	669	38	0.63	4.6	3.97	2.78	2.15
Aiea Stream	304+64	5yr	669	38.44	1.33	4.73	3.4	2.86	1.53
Aiea Stream	304+44	5yr	669	38.98	2.97	4.34	1.37	4.34	1.37
Aiea Stream	304+21	5yr	669	37.88	4.4	2.77	-1.63	2.77	-1.63
Aiea Stream	303+93	5yr	669	36.07	1.78	1.78	0	1.78	0
Aiea Stream	303+59	5yr	669	34.42	2.59	2.59	0	2.59	0
Aiea Stream	303+19	5yr	669	32.8	1.67	1.67	0	1.67	0
Aiea Stream	302+92	5yr	669	31.98	2.95	2.95	0	2.95	0
Aiea Stream	302+50	5yr	669	29.8	1.46	1.46	0	1.46	0
Aiea Stream	302+10	5yr	669	30.4	0.44	0.44	0	0.44	0
Aiea Stream	301+78	5yr	669	29.98	1.73	1.73	0	1.73	0
Aiea Stream	301+49	5yr	669	29.92	1.98	1.98	0	1.98	0
Aiea Stream	301+22	5yr	669	29.85	3.04	3.04	0	3.04	0
Aiea Stream	300+95	5yr	669	28.31	2.29	2.29	0	2.29	0
Aiea Stream	300+68	5yr	669	26	1.73	1.73	0	1.73	0
Aiea Stream	300+42	5yr	669	25.8	1.69	1.69	0	1.69	0
Aiea Stream	300+16	5yr	669	26.54	2.13	2.13	0	2.13	0

HEC-RAS Profile Right Bank Velocity Comparision: 10-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Right Existing	Vel Right Proposed n=0.03	Vel Right Diff n=0.03	Vel Right Proposed n=0.05	Vel Right Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	10yr	919	63.94	1.37	1.37	0	1.37	0
Aiea Stream	310+87	10yr	919	63.36	1.32	1.32	0	1.32	0
Aiea Stream	310+57	10yr	919	61.97	1.28	1.28	0	1.28	0
Aiea Stream	310+25	10yr	919	61.02	1.46	1.78	0.32	1.78	0.32
Aiea Stream	309+97	10yr	919	60	1.13	1.13	0	1.13	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	10yr	919	59	0.89	0.89	0	0.89	0
Aiea Stream	309+32	10yr	919	57	5.07	5.07	0	5.07	0
Aiea Stream	309+08	10yr	919	55.95	2.03	2.03	0	2.03	0
Aiea Stream	308+89	10yr	919	55.45	2.01	2.01	0	2.01	0
Aiea Stream	308+69	10yr	919	54.64	1.91	1.91	0	1.91	0
Aiea Stream	308+54	10yr	919	53.98	1.45	1.45	0	1.45	0
Aiea Stream	308+42	10yr	919	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	10yr	919	45.7	0.66	3.29	2.63	1.97	1.31
Aiea Stream	306+46	10yr	919	44.78	1.07	5.61	4.54	3.39	2.32
Aiea Stream	306+29	10yr	919	41.5	0.47	2.77	2.3	1.66	1.19
Aiea Stream	306+09	10yr	919	45.04	2.2	8.69	6.49	5.25	3.05
Aiea Stream	305+79	10yr	919	43.94	1.13	5.86	4.73	3.54	2.41
Aiea Stream	305+51	10yr	919	43.74	1.72	10.37	8.65	6.29	4.57
Aiea Stream	305+23	10yr	919	42.18	1.79	8.91	7.12	5.37	3.58
Aiea Stream	304+92	10yr	919	39.37	1.8	6.64	4.84	4.01	2.21
Aiea Stream	304+84	10yr	919	38	0.82	5.96	5.14	3.62	2.8
Aiea Stream	304+64	10yr	919	38.44	1.8	6.08	4.28	3.7	1.9
Aiea Stream	304+44	10yr	919	38.98	3.46	5.54	2.08	5.54	2.08
Aiea Stream	304+21	10yr	919	37.88	5.34	3.58	-1.76	3.58	-1.76
Aiea Stream	303+93	10yr	919	36.07	2.16	2.16	0	2.16	0
Aiea Stream	303+59	10yr	919	34.42	2.96	2.96	0	2.96	0
Aiea Stream	303+19	10yr	919	32.8	2.08	2.08	0	2.08	0
Aiea Stream	302+92	10yr	919	31.98	3.57	3.57	0	3.57	0
Aiea Stream	302+50	10yr	919	29.8	1.67	1.67	0	1.67	0
Aiea Stream	302+10	10yr	919	30.4	0.55	0.55	0	0.55	0
Aiea Stream	301+78	10yr	919	29.98	2.21	2.21	0	2.21	0
Aiea Stream	301+49	10yr	919	29.92	2.41	2.41	0	2.41	0
Aiea Stream	301+22	10yr	919	29.85	3.33	3.33	0	3.33	0
Aiea Stream	300+95	10yr	919	28.31	2.61	2.61	0	2.61	0
Aiea Stream	300+68	10yr	919	26	1.88	1.88	0	1.88	0
Aiea Stream	300+42	10yr	919	25.8	1.87	1.87	0	1.87	0
Aiea Stream	300+16	10yr	919	26.54	2.61	2.61	0	2.61	0

HEC-RAS Profile Right Bank Velocity Comparision: 25-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Right Existing	Vel Right Proposed n=0.03	Vel Right Diff n=0.03	Vel Right Proposed n=0.05	Vel Right Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	25yr	1916	63.94	2.33	2.33	0	2.33	0
Aiea Stream	310+87	25yr	1916	63.36	2.16	2.16	0	2.16	0
Aiea Stream	310+57	25yr	1916	61.97	2.03	2.02	-0.01	2.02	-0.01
Aiea Stream	310+25	25yr	1916	61.02	2.25	2.44	0.19	2.44	0.19
Aiea Stream	309+97	25yr	1916	60	1.65	1.65	0	1.65	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	25yr	1916	59	1.24	1.24	0	1.24	0
Aiea Stream	309+32	25yr	1916	57	6.44	6.44	0	6.44	0
Aiea Stream	309+08	25yr	1916	55.95	3.41	3.41	0	3.41	0
Aiea Stream	308+89	25yr	1916	55.45	3.58	3.58	0	3.58	0
Aiea Stream	308+69	25yr	1916	54.64	2.56	2.56	0	2.56	0
Aiea Stream	308+54	25yr	1916	53.98	2.67	2.67	0	2.67	0
Aiea Stream	308+42	25yr	1916	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	25yr	1916	45.7	0.95	4.8	3.85	2.89	1.94
Aiea Stream	306+46	25yr	1916	44.78	1.42	7.5	6.08	4.6	3.18
Aiea Stream	306+29	25yr	1916	41.5	0.85	5.02	4.17	3.04	2.19
Aiea Stream	306+09	25yr	1916	45.04	3.18	12.79	9.61	7.87	4.69
Aiea Stream	305+79	25yr	1916	43.94	1.58	8.4	6.82	5.21	3.63
Aiea Stream	305+51	25yr	1916	43.74	2.4	15.59	13.19	9.61	7.21
Aiea Stream	305+23	25yr	1916	42.18	2.69	13.8	11.11	8.36	5.67
Aiea Stream	304+92	25yr	1916	39.37	2.78	10.34	7.56	6.29	3.51
Aiea Stream	304+84	25yr	1916	38	1.38	9.84	8.46	6.11	4.73
Aiea Stream	304+64	25yr	1916	38.44	3.21	10.18	6.97	6.4	3.19
Aiea Stream	304+44	25yr	1916	38.98	4.28	8.97	4.69	8.97	4.69
Aiea Stream	304+21	25yr	1916	37.88	6.74	6.03	-0.71	6.03	-0.71
Aiea Stream	303+93	25yr	1916	36.07	2.58	2.58	0	2.58	0
Aiea Stream	303+59	25yr	1916	34.42	3.78	3.78	0	3.78	0
Aiea Stream	303+19	25yr	1916	32.8	3.21	3.21	0	3.21	0
Aiea Stream	302+92	25yr	1916	31.98	5.19	5.19	0	5.19	0
Aiea Stream	302+50	25yr	1916	29.8	2.19	2.19	0	2.19	0
Aiea Stream	302+10	25yr	1916	30.4	0.9	0.9	0	0.9	0
Aiea Stream	301+78	25yr	1916	29.98	3.56	3.56	0	3.56	0
Aiea Stream	301+49	25yr	1916	29.92	3.27	3.27	0	3.27	0
Aiea Stream	301+22	25yr	1916	29.85	4.67	4.67	0	4.67	0
Aiea Stream	300+95	25yr	1916	28.31	3.73	3.73	0	3.73	0
Aiea Stream	300+68	25yr	1916	26	2.7	2.7	0	2.7	0
Aiea Stream	300+42	25yr	1916	25.8	2.44	2.44	0	2.44	0
Aiea Stream	300+16	25yr	1916	26.54	3.35	3.35	0	3.35	0

HEC-RAS Profile Right Bank Velocity Comparision: 50-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Right Existing	Vel Right Proposed n=0.03	Vel Right Diff n=0.03	Vel Right Proposed n=0.05	Vel Right Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	50yr	2321	63.94	2.6	2.6	0	2.6	0
Aiea Stream	310+87	50yr	2321	63.36	2.33	2.32	-0.01	2.32	-0.01
Aiea Stream	310+57	50yr	2321	61.97	2.17	2.16	-0.01	2.16	-0.01
Aiea Stream	310+25	50yr	2321	61.02	2.37	2.53	0.16	2.53	0.16
Aiea Stream	309+97	50yr	2321	60	1.75	1.75	0	1.75	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	50yr	2321	59	1.31	1.31	0	1.31	0
Aiea Stream	309+32	50yr	2321	57	6.65	6.65	0	6.65	0
Aiea Stream	309+08	50yr	2321	55.95	3.64	3.64	0	3.64	0
Aiea Stream	308+89	50yr	2321	55.45	3.98	3.98	0	3.98	0
Aiea Stream	308+69	50yr	2321	54.64	3.45	3.45	0	3.45	0
Aiea Stream	308+54	50yr	2321	53.98	2.97	2.97	0	2.97	0
Aiea Stream	308+42	50yr	2321	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	50yr	2321	45.7	1.04	5.27	4.23	3.18	2.14
Aiea Stream	306+46	50yr	2321	44.78	1.53	8.05	6.52	4.96	3.43
Aiea Stream	306+29	50yr	2321	41.5	0.97	5.74	4.77	3.49	2.52
Aiea Stream	306+09	50yr	2321	45.04	3.42	13.84	10.42	8.59	5.17
Aiea Stream	305+79	50yr	2321	43.94	1.71	9.07	7.36	5.7	3.99
Aiea Stream	305+51	50yr	2321	43.74	2.59	16.76	14.17	10.41	7.82
Aiea Stream	305+23	50yr	2321	42.18	2.95	15.86	12.91	9.13	6.18
Aiea Stream	304+92	50yr	2321	39.37	3.11	11.5	8.39	6.94	3.83
Aiea Stream	304+84	50yr	2321	38	1.57	11.04	9.47	6.84	5.27
Aiea Stream	304+64	50yr	2321	38.44	3.7	11.65	7.95	7.23	3.53
Aiea Stream	304+44	50yr	2321	38.98	4.5	9.79	5.29	9.79	5.29
Aiea Stream	304+21	50yr	2321	37.88	6.95	6.8	-0.15	6.8	-0.15
Aiea Stream	303+93	50yr	2321	36.07	2.71	2.71	0	2.71	0
Aiea Stream	303+59	50yr	2321	34.42	4.03	4.03	0	4.03	0
Aiea Stream	303+19	50yr	2321	32.8	3.53	3.53	0	3.53	0
Aiea Stream	302+92	50yr	2321	31.98	5.63	5.63	0	5.63	0
Aiea Stream	302+50	50yr	2321	29.8	2.38	2.38	0	2.38	0
Aiea Stream	302+10	50yr	2321	30.4	1.03	1.03	0	1.03	0
Aiea Stream	301+78	50yr	2321	29.98	4.08	4.08	0	4.08	0
Aiea Stream	301+49	50yr	2321	29.92	3.62	3.62	0	3.62	0
Aiea Stream	301+22	50yr	2321	29.85	4.92	4.92	0	4.92	0
Aiea Stream	300+95	50yr	2321	28.31	3.94	3.94	0	3.94	0
Aiea Stream	300+68	50yr	2321	26	2.89	2.89	0	2.89	0
Aiea Stream	300+42	50yr	2321	25.8	2.62	2.62	0	2.62	0
Aiea Stream	300+16	50yr	2321	26.54	3.5	3.5	0	3.5	0

HEC-RAS Profile Right Bank Velocity Comparision: 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Right Existing	Vel Right Proposed n=0.03	Vel Right Diff n=0.03	Vel Right Proposed n=0.05	Vel Right Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	100yr	2743	63.94	2.82	2.82	0	2.82	0
Aiea Stream	310+87	100yr	2743	63.36	2.43	2.42	-0.01	2.42	-0.01
Aiea Stream	310+57	100yr	2743	61.97	2.26	2.26	0	2.26	0
Aiea Stream	310+25	100yr	2743	61.02	2.45	2.59	0.14	2.59	0.14
Aiea Stream	309+97	100yr	2743	60	1.83	1.83	0	1.83	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	100yr	2743	59	1.39	1.39	0	1.39	0
Aiea Stream	309+32	100yr	2743	57	6.72	6.72	0	6.72	0
Aiea Stream	309+08	100yr	2743	55.95	3.81	3.81	0	3.81	0
Aiea Stream	308+89	100yr	2743	55.45	4.28	4.28	0	4.28	0
Aiea Stream	308+69	100yr	2743	54.64	4.08	4.08	0	4.08	0
Aiea Stream	308+54	100yr	2743	53.98	3.24	3.24	0	3.24	0
Aiea Stream	308+42	100yr	2743	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	100yr	2743	45.7	1.13	5.71	4.58	3.46	2.33
Aiea Stream	306+46	100yr	2743	44.78	1.64	8.56	6.92	5.31	3.67
Aiea Stream	306+29	100yr	2743	41.5	1.09	6.43	5.34	3.93	2.84
Aiea Stream	306+09	100yr	2743	45.04	3.69	14.75	11.06	9.24	5.55
Aiea Stream	305+79	100yr	2743	43.94	1.83	9.67	7.84	6.15	4.32
Aiea Stream	305+51	100yr	2743	43.74	2.76	17.74	14.98	11.1	8.34
Aiea Stream	305+23	100yr	2743	42.18	3.18	17.23	14.05	9.8	6.62
Aiea Stream	304+92	100yr	2743	39.37	3.43	12.53	9.1	7.54	4.11
Aiea Stream	304+84	100yr	2743	38	1.75	12.11	10.36	7.52	5.77
Aiea Stream	304+64	100yr	2743	38.44	4.23	12.83	8.6	8.02	3.79
Aiea Stream	304+44	100yr	2743	38.98	4.61	10.53	5.92	10.53	5.92
Aiea Stream	304+21	100yr	2743	37.88	7.24	7.55	0.31	7.55	0.31
Aiea Stream	303+93	100yr	2743	36.07	2.89	2.89	0	2.89	0
Aiea Stream	303+59	100yr	2743	34.42	4.29	4.29	0	4.29	0
Aiea Stream	303+19	100yr	2743	32.8	3.89	3.89	0	3.89	0
Aiea Stream	302+92	100yr	2743	31.98	5.87	5.87	0	5.87	0
Aiea Stream	302+50	100yr	2743	29.8	1.99	1.99	0	1.99	0
Aiea Stream	302+10	100yr	2743	30.4	1.16	1.16	0	1.16	0
Aiea Stream	301+78	100yr	2743	29.98	4.55	4.55	0	4.55	0
Aiea Stream	301+49	100yr	2743	29.92	3.96	3.96	0	3.96	0
Aiea Stream	301+22	100yr	2743	29.85	5.05	5.05	0	5.05	0
Aiea Stream	300+95	100yr	2743	28.31	4.09	4.09	0	4.09	0
Aiea Stream	300+68	100yr	2743	26	3.06	3.06	0	3.06	0
Aiea Stream	300+42	100yr	2743	25.8	2.77	2.77	0	2.77	0
Aiea Stream	300+16	100yr	2743	26.54	3.63	3.63	0	3.63	0

HEC-RAS Profile Right Bank Velocity Comparision: USACE 100-Year Flood

Reach	River Sta	Profile	Q Total	Min Ch El	Vel Right Existing	Vel Right Proposed n=0.03	Vel Right Diff n=0.03	Vel Right Proposed n=0.05	Vel Right Diff n=0.05
			(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Aiea Stream	311+19	USACE100yr	3850	63.94	2.9	2.9	0	2.9	0
Aiea Stream	310+87	USACE100yr	3850	63.36	2.27	2.27	0	2.27	0
Aiea Stream	310+57	USACE100yr	3850	61.97	2.21	2.2	-0.01	2.2	-0.01
Aiea Stream	310+25	USACE100yr	3850	61.02	2.31	2.4	0.09	2.4	0.09
Aiea Stream	309+97	USACE100yr	3850	60	1.84	1.84	0	1.84	0
Aiea Stream	309+91		Culvert						
Aiea Stream	309+49	USACE100yr	3850	59	1.58	1.58	0	1.58	0
Aiea Stream	309+32	USACE100yr	3850	57	6.02	6.02	0	6.02	0
Aiea Stream	309+08	USACE100yr	3850	55.95	4	4	0	4	0
Aiea Stream	308+89	USACE100yr	3850	55.45	4.75	4.75	0	4.75	0
Aiea Stream	308+69	USACE100yr	3850	54.64	5.06	5.06	0	5.06	0
Aiea Stream	308+54	USACE100yr	3850	53.98	3.79	3.79	0	3.79	0
Aiea Stream	308+42	USACE100yr	3850	47.45			0		0
Aiea Stream	308+41		Culvert						
Aiea Stream	306+62	USACE100yr	3850	45.7	1.33	6.7	5.37	4.1	2.77
Aiea Stream	306+46	USACE100yr	3850	44.78	1.85	9.57	7.72	6.08	4.23
Aiea Stream	306+29	USACE100yr	3850	41.5	1.38	8	6.62	4.96	3.58
Aiea Stream	306+09	USACE100yr	3850	45.04	4.17	16.6	12.43	10.67	6.5
Aiea Stream	305+79	USACE100yr	3850	43.94	2.1	10.91	8.81	7.17	5.07
Aiea Stream	305+51	USACE100yr	3850	43.74	3.1	19.71	16.61	12.56	9.46
Aiea Stream	305+23	USACE100yr	3850	42.18	3.65	19.98	16.33	11.31	7.66
Aiea Stream	304+92	USACE100yr	3850	39.37	4	15.26	11.26	9.07	5.07
Aiea Stream	304+84	USACE100yr	3850	38	2.18	14.86	12.68	9.38	7.2
Aiea Stream	304+64	USACE100yr	3850	38.44	5.11	15	9.89	9.29	4.18
Aiea Stream	304+44	USACE100yr	3850	38.98	5.39	13.34	7.95	13.67	8.28
Aiea Stream	304+21	USACE100yr	3850	37.88	7.64	8.91	1.27	8.91	1.27
Aiea Stream	303+93	USACE100yr	3850	36.07	3.33	3.33	0	3.33	0
Aiea Stream	303+59	USACE100yr	3850	34.42	4.74	4.74	0	4.74	0
Aiea Stream	303+19	USACE100yr	3850	32.8	4.75	4.75	0	4.75	0
Aiea Stream	302+92	USACE100yr	3850	31.98	6.46	6.46	0	6.46	0
Aiea Stream	302+50	USACE100yr	3850	29.8	2.6	2.6	0	2.6	0
Aiea Stream	302+10	USACE100yr	3850	30.4	1.26	1.26	0	1.26	0
Aiea Stream	301+78	USACE100yr	3850	29.98	5.13	5.13	0	5.13	0
Aiea Stream	301+49	USACE100yr	3850	29.92	4.51	4.51	0	4.51	0
Aiea Stream	301+22	USACE100yr	3850	29.85	5.23	5.23	0	5.23	0
Aiea Stream	300+95	USACE100yr	3850	28.31	4.37	4.37	0	4.37	0
Aiea Stream	300+68	USACE100yr	3850	26	3.36	3.36	0	3.36	0
Aiea Stream	300+42	USACE100yr	3850	25.8	3.06	3.06	0	3.06	0
Aiea Stream	300+16	USACE100yr	3850	26.54	3.88	3.88	0	3.88	0

APPENDIX 23

Superelevation Calculation

Superelevation Calculation for Proposed Condition (n=0.03): 2-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	3.53	197.13	4.21	0.11	0.28	8.47	10.71	57.64	60.00	45.70	49.23	49.51
306+46	30.21	4.14	197.13	4.65	0.13	0.34	9.12	9.01	57.97	58.00	44.78	48.92	49.26
306+29	25.72	7.40	197.13	2.93	0.05	0.13	9.06	13.07	57.93	62.00	41.50	48.90	49.03
306+09	21.69	3.23	197.13	6.27	0.18	0.61	11.72	13.82	59.90	62.18	45.04	48.27	48.88
305+79	23.63	3.47	197.13	5.91	0.17	0.54	11.48	12.49	58.80	59.99	43.94	47.41	47.95
305+51	21.84	2.82	197.13	6.70	0.20	0.70	11.53	15.33	57.99	61.99	43.74	46.56	47.26
305+23	24.74	2.36	197.13	7.80	0.29	0.95	13.60	15.29	58.00	59.98	42.18	44.54	45.49
304+92	20.95	3.67	98.18	5.83	0.31	0.52	15.29	14.89	58.17	58.09	39.37	43.04	43.56
304+84	21.70	5.00	98.18	5.04	0.26	0.39	15.13	14.92	58.00	58.05	38.00	43.00	43.39
304+64	19.77	4.29	98.18	5.36	0.26	0.44	15.42	14.94	58.02	57.80	38.44	42.73	43.17
304+44	21.03	3.07	98.18	6.67	0.39	0.69	6.36	13.85	48.21	56.10	38.98	42.05	42.74
304+21	23.36	2.66	98.18	7.31	0.50	0.83	6.38	13.21	46.67	54.00	37.88	40.54	41.37
303+93	26.00	2.92	98.18	7.28	0.55	0.82	7.65	15.73	46.36	55.00	36.07	38.99	39.81
303+59	20.03	3.56	98.18	7.22	0.46	0.81	6.46	15.74	44.21	53.95	34.42	37.98	38.79
303+19	18.15	4.49	98.18	6.37	0.36	0.62	5.72	12.68	42.83	50.15	32.80	37.29	37.91

Superelevation Calculation for Proposed Condition (n=0.05): 2-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	3.53	197.13	4.21	0.11	0.28	8.47	10.71	57.64	60.00	45.70	49.23	49.51
306+46	30.21	4.15	197.13	4.65	0.13	0.33	9.11	9.00	57.97	58.00	44.78	48.93	49.26
306+29	25.72	7.40	197.13	2.93	0.05	0.13	9.06	13.07	57.93	62.00	41.50	48.90	49.03
306+09	21.69	3.24	197.13	6.27	0.18	0.61	11.71	13.81	59.90	62.18	45.04	48.28	48.89
305+79	23.63	3.47	197.13	5.91	0.17	0.54	11.48	12.49	58.80	59.99	43.94	47.41	47.95
305+51	21.84	2.83	197.13	6.71	0.20	0.69	11.52	15.32	57.99	61.99	43.74	46.57	47.26
305+23	24.74	2.36	197.13	7.79	0.29	0.95	13.60	15.30	58.00	59.98	42.18	44.54	45.49
304+92	20.95	3.67	98.18	5.84	0.31	0.53	15.29	14.89	58.17	58.09	39.37	43.04	43.57
304+84	21.70	5.00	98.18	5.05	0.26	0.39	15.13	14.92	58.00	58.05	38.00	43.00	43.39
304+64	19.77	4.29	98.18	5.37	0.26	0.44	15.42	14.94	58.02	57.80	38.44	42.73	43.17
304+44	21.03	3.07	98.18	6.67	0.39	0.69	6.36	13.85	48.21	56.10	38.98	42.05	42.74
304+21	23.36	2.66	98.18	7.31	0.50	0.83	6.38	13.21	46.67	54.00	37.88	40.54	41.37
303+93	26.00	2.92	98.18	7.28	0.55	0.82	7.65	15.73	46.36	55.00	36.07	38.99	39.81
303+59	20.03	3.56	98.18	7.22	0.46	0.81	6.46	15.74	44.21	53.95	34.42	37.98	38.79
303+19	18.15	4.49	98.18	6.37	0.36	0.62	5.72	12.68	42.83	50.15	32.80	37.29	37.91

Superelevation Calculation for Existing Condition: 2-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	3.68	197.13	3.97	0.10	0.25	8.31	10.57	57.64	60.00	45.70	49.38	49.63
306+46	30.21	4.36	197.13	4.32	0.12	0.29	8.89	8.80	57.97	58.00	44.78	49.14	49.43
306+29	25.72	7.62	197.13	2.84	0.05	0.13	8.84	12.85	57.93	62.00	41.50	49.12	49.25
306+09	21.69	3.37	197.13	6.66	0.20	0.69	11.59	13.67	59.90	62.18	45.04	48.41	49.10
305+79	23.63	3.56	197.13	5.91	0.17	0.54	11.39	12.40	58.80	59.99	43.94	47.50	48.04
305+51	21.84	2.80	197.13	7.05	0.22	0.77	11.56	15.34	57.99	61.99	43.74	46.54	47.31
305+23	24.74	2.37	197.13	7.55	0.27	0.88	13.58	15.29	58.00	59.98	42.18	44.55	45.43
304+92	20.95	3.73	98.18	5.71	0.30	0.51	15.22	14.84	58.17	58.09	39.37	43.10	43.61
304+84	21.70	5.12	98.18	4.47	0.20	0.31	14.98	14.83	58.00	58.05	38.00	43.12	43.43
304+64	19.77	4.34	98.18	5.41	0.27	0.46	15.37	14.89	58.02	57.80	38.44	42.78	43.24
304+44	21.03	3.03	98.18	6.99	0.43	0.76	6.42	13.87	48.21	56.10	38.98	42.01	42.77
304+21	23.36	2.67	98.18	7.08	0.47	0.77	6.36	13.21	46.67	54.00	37.88	40.55	41.32
303+93	26.00	2.92	98.18	7.28	0.55	0.82	7.65	15.73	46.36	55.00	36.07	38.99	39.81
303+59	20.03	3.56	98.18	7.22	0.46	0.81	6.46	15.74	44.21	53.95	34.42	37.98	38.79
303+19	18.15	4.49	98.18	6.37	0.36	0.62	5.72	12.68	42.83	50.15	32.80	37.29	37.91

Superelevation Calculation for Proposed Condition (n=0.03): 5-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	4.83	197.13	5.05	0.17	0.40	7.20	9.38	57.64	60.00	45.70	50.53	50.93
306+46	30.21	5.48	197.13	5.45	0.19	0.45	7.81	7.64	57.97	58.00	44.78	50.26	50.71
306+29	25.72	8.74	197.13	4.11	0.12	0.26	7.75	11.70	57.93	62.00	41.50	50.24	50.50
306+09	21.69	4.32	197.13	7.80	0.30	0.94	10.69	12.67	59.90	62.18	45.04	49.36	50.30
305+79	23.63	4.61	197.13	7.31	0.28	0.82	10.39	11.29	58.80	59.99	43.94	48.55	49.37
305+51	21.84	3.75	197.13	8.64	0.35	1.16	10.68	14.32	57.99	61.99	43.74	47.49	48.65
305+23	24.74	3.38	197.13	9.26	0.44	1.33	12.66	14.20	58.00	59.98	42.18	45.56	46.89
304+92	20.95	4.96	98.18	7.26	0.53	0.81	14.11	13.49	58.17	58.09	39.37	44.33	45.14
304+84	21.70	6.28	98.18	6.65	0.49	0.68	13.97	13.52	58.00	58.05	38.00	44.28	44.96
304+64	19.77	5.50	98.18	7.03	0.50	0.76	14.33	13.61	58.02	57.80	38.44	43.94	44.70
304+44	21.03	4.17	98.18	8.31	0.67	1.06	5.40	12.61	48.21	56.10	38.98	43.15	44.21
304+21	23.36	3.52	98.18	9.43	0.91	1.37	5.72	12.15	46.67	54.00	37.88	41.40	42.77
303+93	26.00	3.97	98.18	8.39	0.79	1.07	6.72	14.56	46.36	55.00	36.07	40.04	41.11
303+59	20.03	4.91	98.18	8.20	0.66	1.00	5.21	14.29	44.21	53.95	34.42	39.33	40.33
303+19	18.15	5.91	98.18	7.82	0.60	0.94	4.42	11.13	42.83	50.15	32.80	38.71	39.65

Superelevation Calculation for Proposed Condition (n=0.05): 5-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	4.85	197.13	5.04	0.17	0.39	7.18	9.36	57.64	60.00	45.70	50.55	50.94
306+46	30.21	5.49	197.13	5.47	0.20	0.46	7.80	7.63	57.97	58.00	44.78	50.27	50.73
306+29	25.72	8.75	197.13	4.11	0.12	0.26	7.74	11.69	57.93	62.00	41.50	50.25	50.51
306+09	21.69	4.33	197.13	7.81	0.30	0.94	10.68	12.66	59.90	62.18	45.04	49.37	50.31
305+79	23.63	4.62	197.13	7.32	0.28	0.82	10.38	11.28	58.80	59.99	43.94	48.56	49.38
305+51	21.84	3.76	197.13	8.69	0.36	1.16	10.67	14.31	57.99	61.99	43.74	47.50	48.66
305+23	24.74	3.39	197.13	9.26	0.44	1.33	12.65	14.19	58.00	59.98	42.18	45.57	46.90
304+92	20.95	4.96	98.18	7.29	0.54	0.81	14.11	13.49	58.17	58.09	39.37	44.33	45.14
304+84	21.70	6.28	98.18	6.71	0.50	0.69	13.97	13.52	58.00	58.05	38.00	44.28	44.97
304+64	19.77	5.49	98.18	7.09	0.51	0.77	14.34	13.62	58.02	57.80	38.44	43.93	44.70
304+44	21.03	4.17	98.18	8.31	0.67	1.06	5.40	12.61	48.21	56.10	38.98	43.15	44.21
304+21	23.36	3.52	98.18	9.43	0.91	1.37	5.72	12.15	46.67	54.00	37.88	41.40	42.77
303+93	26.00	3.97	98.18	8.39	0.79	1.07	6.72	14.56	46.36	55.00	36.07	40.04	41.11
303+59	20.03	4.91	98.18	8.20	0.66	1.00	5.21	14.29	44.21	53.95	34.42	39.33	40.33
303+19	18.15	5.91	98.18	7.82	0.60	0.94	4.42	11.13	42.83	50.15	32.80	38.71	39.65

Superelevation Calculation for Existing Condition: 5-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	5.06	197.13	4.77	0.16	0.35	6.96	9.16	57.64	60.00	45.70	50.76	51.11
306+46	30.21	5.73	197.13	5.19	0.18	0.42	7.55	7.40	57.97	58.00	44.78	50.51	50.93
306+29	25.72	9.00	197.13	3.99	0.11	0.25	7.49	11.44	57.93	62.00	41.50	50.50	50.75
306+09	21.69	4.46	197.13	8.25	0.34	1.04	10.57	12.51	59.90	62.18	45.04	49.50	50.54
305+79	23.63	4.74	197.13	7.28	0.28	0.82	10.26	11.16	58.80	59.99	43.94	48.68	49.50
305+51	21.84	3.64	197.13	9.34	0.41	1.35	10.82	14.40	57.99	61.99	43.74	47.38	48.73
305+23	24.74	3.40	197.13	8.88	0.40	1.22	12.62	14.20	58.00	59.98	42.18	45.58	46.80
304+92	20.95	5.05	98.18	7.11	0.51	0.78	14.01	13.41	58.17	58.09	39.37	44.42	45.20
304+84	21.70	6.46	98.18	5.92	0.39	0.54	13.74	13.39	58.00	58.05	38.00	44.46	45.00
304+64	19.77	5.55	98.18	7.11	0.51	0.78	14.28	13.55	58.02	57.80	38.44	43.99	44.77
304+44	21.03	3.94	98.18	9.10	0.80	1.28	5.69	12.78	48.21	56.10	38.98	42.92	44.20
304+21	23.36	3.51	98.18	8.96	0.81	1.21	5.69	12.20	46.67	54.00	37.88	41.39	42.60
303+93	26.00	3.97	98.18	8.39	0.79	1.07	6.72	14.56	46.36	55.00	36.07	40.04	41.11
303+59	20.03	4.91	98.18	8.20	0.66	1.00	5.21	14.29	44.21	53.95	34.42	39.33	40.33
303+19	18.15	5.91	98.18	7.82	0.60	0.94	4.42	11.13	42.83	50.15	32.80	38.71	39.65

Superelevation Calculation for Proposed Condition (n=0.03): 10-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	5.76	197.13	5.61	0.22	0.49	6.29	8.43	57.64	60.00	45.70	51.46	51.95
306+46	30.21	6.41	197.13	5.99	0.25	0.56	6.90	6.69	57.97	58.00	44.78	51.19	51.75
306+29	25.72	9.67	197.13	4.90	0.17	0.37	6.85	10.74	57.93	62.00	41.50	51.17	51.54
306+09	21.69	5.10	197.13	8.71	0.39	1.16	9.96	11.84	59.90	62.18	45.04	50.14	51.30
305+79	23.63	5.44	197.13	8.12	0.37	1.01	9.60	10.42	58.80	59.99	43.94	49.38	50.39
305+51	21.84	4.36	197.13	9.98	0.50	1.55	10.14	13.64	57.99	61.99	43.74	48.10	49.65
305+23	24.74	4.12	197.13	10.18	0.56	1.60	11.98	13.40	58.00	59.98	42.18	46.30	47.90
304+92	20.95	5.81	98.18	8.25	0.73	1.04	13.36	12.54	58.17	58.09	39.37	45.18	46.22
304+84	21.70	7.13	98.18	7.73	0.71	0.91	13.22	12.56	58.00	58.05	38.00	45.13	46.04
304+64	19.77	6.30	98.18	8.16	0.71	1.01	13.63	12.70	58.02	57.80	38.44	44.74	45.75
304+44	21.03	4.94	98.18	9.33	0.90	1.31	4.74	11.73	48.21	56.10	38.98	43.92	45.23
304+21	23.36	4.16	98.18	10.67	1.23	1.74	5.25	11.34	46.67	54.00	37.88	42.04	43.78
303+93	26.00	4.86	98.18	8.78	0.92	1.17	5.89	13.61	46.36	55.00	36.07	40.93	42.10
303+59	20.03	5.92	98.18	8.78	0.82	1.14	4.28	13.20	44.21	53.95	34.42	40.34	41.48
303+19	18.15	6.92	98.18	8.76	0.82	1.17	3.52	10.02	42.83	50.15	32.80	39.72	40.89

Superelevation Calculation for Proposed Condition (n=0.05): 10-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	5.79	197.13	5.59	0.22	0.49	6.26	8.40	57.64	60.00	45.70	51.49	51.98
306+46	30.21	6.43	197.13	6.04	0.25	0.56	6.89	6.66	57.97	58.00	44.78	51.21	51.77
306+29	25.72	9.69	197.13	4.90	0.17	0.37	6.83	10.72	57.93	62.00	41.50	51.19	51.56
306+09	21.69	5.12	197.13	8.74	0.39	1.16	9.94	11.82	59.90	62.18	45.04	50.16	51.32
305+79	23.63	5.45	197.13	8.18	0.37	1.02	9.60	10.41	58.80	59.99	43.94	49.39	50.41
305+51	21.84	4.38	197.13	10.06	0.50	1.55	10.12	13.62	57.99	61.99	43.74	48.12	49.67
305+23	24.74	4.13	197.13	10.20	0.56	1.61	11.97	13.39	58.00	59.98	42.18	46.31	47.92
304+92	20.95	5.82	98.18	8.31	0.75	1.05	13.35	12.53	58.17	58.09	39.37	45.19	46.24
304+84	21.70	7.12	98.18	7.84	0.73	0.93	13.24	12.56	58.00	58.05	38.00	45.12	46.05
304+64	19.77	6.27	98.18	8.29	0.73	1.05	13.67	12.72	58.02	57.80	38.44	44.71	45.76
304+44	21.03	4.94	98.18	9.33	0.90	1.31	4.74	11.73	48.21	56.10	38.98	43.92	45.23
304+21	23.36	4.16	98.18	10.67	1.23	1.74	5.25	11.34	46.67	54.00	37.88	42.04	43.78
303+93	26.00	4.86	98.18	8.78	0.92	1.17	5.89	13.61	46.36	55.00	36.07	40.93	42.10
303+59	20.03	5.92	98.18	8.78	0.82	1.14	4.28	13.20	44.21	53.95	34.42	40.34	41.48
303+19	18.15	6.92	98.18	8.76	0.82	1.17	3.52	10.02	42.83	50.15	32.80	39.72	40.89

Superelevation Calculation for Existing Condition: 10-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	6.05	197.13	5.31	0.20	0.43	5.99	8.15	57.64	60.00	45.70	51.75	52.18
306+46	30.21	6.70	197.13	5.79	0.23	0.52	6.61	6.40	57.97	58.00	44.78	51.48	52.00
306+29	25.72	9.97	197.13	4.77	0.16	0.35	6.54	10.45	57.93	62.00	41.50	51.47	51.82
306+09	21.69	5.28	197.13	9.14	0.44	1.26	9.80	11.64	59.90	62.18	45.04	50.32	51.58
305+79	23.63	5.64	197.13	8.07	0.37	1.00	9.40	10.22	58.80	59.99	43.94	49.58	50.58
305+51	21.84	4.23	197.13	10.84	0.58	1.81	10.31	13.73	57.99	61.99	43.74	47.97	49.78
305+23	24.74	4.18	197.13	9.68	0.50	1.45	11.89	13.37	58.00	59.98	42.18	46.36	47.81
304+92	20.95	5.97	98.18	8.02	0.70	0.99	13.18	12.40	58.17	58.09	39.37	45.34	46.33
304+84	21.70	7.40	98.18	6.88	0.56	0.72	12.88	12.37	58.00	58.05	38.00	45.40	46.12
304+64	19.77	6.40	98.18	8.20	0.72	1.02	13.54	12.60	58.02	57.80	38.44	44.84	45.86
304+44	21.03	4.53	98.18	10.60	1.15	1.71	5.28	12.01	48.21	56.10	38.98	43.51	45.22
304+21	23.36	4.16	98.18	9.93	1.05	1.47	5.16	11.43	46.67	54.00	37.88	42.04	43.51
303+93	26.00	4.86	98.18	8.78	0.92	1.17	5.89	13.61	46.36	55.00	36.07	40.93	42.10
303+59	20.03	5.92	98.18	8.78	0.82	1.14	4.28	13.20	44.21	53.95	34.42	40.34	41.48
303+19	18.15	6.92	98.18	8.76	0.82	1.17	3.52	10.02	42.83	50.15	32.80	39.72	40.89

Superelevation Calculation for Proposed Condition (n=0.03): 25-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	8.67	197.13	7.27	0.43	0.81	3.48	5.42	57.64	60.00	45.70	54.37	55.18
306+46	30.21	9.30	197.13	7.64	0.46	0.90	4.12	3.69	57.97	58.00	44.78	54.08	54.98
306+29	25.72	12.51	197.13	7.22	0.42	0.79	4.13	7.78	57.93	62.00	41.50	54.01	54.80
306+09	21.69	7.64	197.13	10.78	0.70	1.81	7.57	9.15	59.90	62.18	45.04	52.68	54.49
305+79	23.63	8.23	197.13	9.98	0.65	1.48	6.96	7.49	58.80	59.99	43.94	52.17	53.65
305+51	21.84	6.43	197.13	13.04	0.98	2.70	8.31	11.33	57.99	61.99	43.74	50.17	52.87
305+23	24.74	6.39	197.13	12.81	1.02	2.55	9.94	10.90	58.00	59.98	42.18	48.57	51.12
304+92	20.95	8.21	98.18	11.35	1.66	1.93	11.42	9.68	58.17	58.09	39.37	47.58	49.51
304+84	21.70	9.49	98.18	10.94	1.67	1.81	11.34	9.72	58.00	58.05	38.00	47.49	49.30
304+64	19.77	8.34	98.18	11.89	1.79	2.12	12.13	10.12	58.02	57.80	38.44	46.78	48.90
304+44	21.03	6.91	98.18	12.76	2.00	2.35	3.32	9.21	48.21	56.10	38.98	45.89	48.24
304+21	23.36	6.76	98.18	12.57	2.05	2.31	3.05	8.34	46.67	54.00	37.88	44.64	46.95
303+93	26.00	8.18	98.18	9.57	1.30	1.35	2.76	10.10	46.36	55.00	36.07	44.25	45.60
303+59	20.03	9.20	98.18	10.54	1.45	1.58	1.32	9.60	44.21	53.95	34.42	43.62	45.20
303+19	18.15	9.98	98.18	11.39	1.71	1.91	0.90	6.51	42.83	50.15	32.80	42.78	44.69

Superelevation Calculation for Proposed Condition (n=0.05): 25-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	8.71	197.13	7.28	0.43	0.82	3.45	5.38	57.64	60.00	45.70	54.41	55.23
306+46	30.21	9.31	197.13	7.81	0.48	0.93	4.12	3.67	57.97	58.00	44.78	54.09	55.02
306+29	25.72	12.52	197.13	7.28	0.43	0.81	4.13	7.76	57.93	62.00	41.50	54.02	54.83
306+09	21.69	7.69	197.13	11.03	0.74	1.79	7.54	9.08	59.90	62.18	45.04	52.73	54.52
305+79	23.63	8.17	197.13	10.33	0.70	1.58	7.04	7.53	58.80	59.99	43.94	52.11	53.69
305+51	21.84	6.47	197.13	13.37	1.04	2.68	8.30	11.26	57.99	61.99	43.74	50.21	52.89
305+23	24.74	6.46	197.13	12.88	1.04	2.52	9.88	10.82	58.00	59.98	42.18	48.64	51.16
304+92	20.95	8.25	98.18	11.47	1.70	1.95	11.40	9.62	58.17	58.09	39.37	47.62	49.57
304+84	21.70	9.48	98.18	11.31	1.79	1.90	11.42	9.67	58.00	58.05	38.00	47.48	49.38
304+64	19.77	8.14	98.18	12.58	2.01	2.34	12.44	10.22	58.02	57.80	38.44	46.58	48.92
304+44	21.03	6.91	98.18	12.76	2.00	2.35	3.32	9.21	48.21	56.10	38.98	45.89	48.24
304+21	23.36	6.76	98.18	12.57	2.05	2.31	3.05	8.34	46.67	54.00	37.88	44.64	46.95
303+93	26.00	8.18	98.18	9.57	1.30	1.35	2.76	10.10	46.36	55.00	36.07	44.25	45.60
303+59	20.03	9.20	98.18	10.54	1.45	1.58	1.32	9.60	44.21	53.95	34.42	43.62	45.20
303+19	18.15	9.98	98.18	11.39	1.71	1.91	0.90	6.51	42.83	50.15	32.80	42.78	44.69

Superelevation Calculation for Existing Condition: 25-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	9.11	197.13	6.96	0.40	0.75	3.03	4.99	57.64	60.00	45.70	54.81	55.56
306+46	30.21	9.66	197.13	7.66	0.47	0.90	3.76	3.33	57.97	58.00	44.78	54.44	55.34
306+29	25.72	12.88	197.13	7.10	0.42	0.78	3.76	7.41	57.93	62.00	41.50	54.38	55.16
306+09	21.69	8.00	197.13	11.24	0.78	1.82	7.25	8.75	59.90	62.18	45.04	53.04	54.86
305+79	23.63	8.52	197.13	10.25	0.70	1.57	6.69	7.18	58.80	59.99	43.94	52.46	54.03
305+51	21.84	6.59	197.13	13.81	1.12	2.89	8.22	11.10	57.99	61.99	43.74	50.33	53.22
305+23	24.74	6.66	197.13	12.06	0.91	2.22	9.62	10.68	58.00	59.98	42.18	48.84	51.06
304+92	20.95	8.57	98.18	11.00	1.58	1.80	11.02	9.36	58.17	58.09	39.37	47.94	49.74
304+84	21.70	10.01	98.18	9.95	1.40	1.50	10.69	9.34	58.00	58.05	38.00	48.01	49.51
304+64	19.77	8.69	98.18	11.70	1.76	2.03	11.77	9.79	58.02	57.80	38.44	47.13	49.16
304+44	21.03	6.85	98.18	13.38	2.22	2.61	3.49	9.16	48.21	56.10	38.98	45.83	48.44
304+21	23.36	6.88	98.18	11.18	1.60	1.77	2.71	8.44	46.67	54.00	37.88	44.76	46.53
303+93	26.00	8.18	98.18	9.57	1.30	1.35	2.76	10.10	46.36	55.00	36.07	44.25	45.60
303+59	20.03	9.20	98.18	10.54	1.45	1.58	1.32	9.60	44.21	53.95	34.42	43.62	45.20
303+19	18.15	9.98	98.18	11.39	1.71	1.91	0.90	6.51	42.83	50.15	32.80	42.78	44.69

Superelevation Calculation for Proposed Condition (n=0.03): 50-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	9.63	197.13	7.82	0.51	0.94	2.57	4.41	57.64	60.00	45.70	55.33	56.27
306+46	30.21	10.24	197.13	8.19	0.55	1.04	3.22	2.71	57.97	58.00	44.78	55.02	56.06
306+29	25.72	13.43	197.13	7.96	0.54	0.96	3.27	6.80	57.93	62.00	41.50	54.93	55.89
306+09	21.69	8.51	197.13	11.33	0.82	2.01	6.76	8.22	59.90	62.18	45.04	53.55	55.56
305+79	23.63	9.16	197.13	10.51	0.76	1.64	6.08	6.51	58.80	59.99	43.94	53.10	54.74
305+51	21.84	7.23	197.13	13.62	1.13	2.99	7.58	10.45	57.99	61.99	43.74	50.97	53.96
305+23	24.74	6.78	197.13	14.46	1.35	3.26	9.72	10.34	58.00	59.98	42.18	48.96	52.22
304+92	20.95	8.96	98.18	12.33	2.07	2.28	10.87	8.73	58.17	58.09	39.37	48.33	50.61
304+84	21.70	10.24	98.18	11.93	2.09	2.15	10.80	8.76	58.00	58.05	38.00	48.24	50.39
304+64	19.77	8.85	98.18	13.32	2.37	2.65	11.91	9.32	58.02	57.80	38.44	47.29	49.94
304+44	21.03	7.69	98.18	13.41	2.34	2.56	2.71	8.26	48.21	56.10	38.98	46.67	49.23
304+21	23.36	7.72	98.18	12.96	2.31	2.41	2.22	7.25	46.67	54.00	37.88	45.60	48.01
303+93	26.00	9.24	98.18	10.03	1.51	1.47	1.81	8.93	46.36	55.00	36.07	45.31	46.78
303+59	20.03	10.19	98.18	11.27	1.77	1.79	0.48	8.45	44.21	53.95	34.42	44.61	46.40
303+19	18.15	10.98	98.18	12.11	2.05	2.11	0.08	5.34	42.83	50.15	32.80	43.78	45.89

Superelevation Calculation for Proposed Condition (n=0.05): 50-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	9.66	197.13	7.86	0.52	0.95	2.54	4.38	57.64	60.00	45.70	55.36	56.31
306+46	30.21	10.23	197.13	8.43	0.58	1.07	3.25	2.70	57.97	58.00	44.78	55.01	56.08
306+29	25.72	13.41	197.13	8.07	0.55	1.00	3.30	6.81	57.93	62.00	41.50	54.91	55.91
306+09	21.69	8.54	197.13	11.71	0.88	1.99	6.76	8.16	59.90	62.18	45.04	53.58	55.57
305+79	23.63	9.05	197.13	11.03	0.83	1.77	6.23	6.58	58.80	59.99	43.94	52.99	54.76
305+51	21.84	7.28	197.13	14.08	1.21	2.95	7.58	10.36	57.99	61.99	43.74	51.02	53.97
305+23	24.74	7.29	197.13	13.60	1.22	2.79	9.14	9.90	58.00	59.98	42.18	49.47	52.26
304+92	20.95	9.10	98.18	12.36	2.10	2.25	10.75	8.57	58.17	58.09	39.37	48.47	50.72
304+84	21.70	10.31	98.18	12.29	2.24	2.22	10.81	8.62	58.00	58.05	38.00	48.31	50.53
304+64	19.77	8.79	98.18	13.82	2.57	2.81	12.07	9.29	58.02	57.80	38.44	47.23	50.04
304+44	21.03	7.69	98.18	13.41	2.34	2.56	2.71	8.26	48.21	56.10	38.98	46.67	49.23
304+21	23.36	7.72	98.18	12.96	2.31	2.41	2.22	7.25	46.67	54.00	37.88	45.60	48.01
303+93	26.00	9.24	98.18	10.03	1.51	1.47	1.81	8.93	46.36	55.00	36.07	45.31	46.78
303+59	20.03	10.19	98.18	11.27	1.77	1.79	0.48	8.45	44.21	53.95	34.42	44.61	46.40
303+19	18.15	10.98	98.18	12.11	2.05	2.11	0.08	5.34	42.83	50.15	32.80	43.78	45.89

Superelevation Calculation for Existing Condition: 50-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	10.12	197.13	7.51	0.48	0.87	2.06	3.94	57.64	60.00	45.70	55.82	56.69
306+46	30.21	10.62	197.13	8.29	0.57	1.05	2.85	2.32	57.97	58.00	44.78	55.40	56.45
306+29	25.72	13.83	197.13	7.88	0.53	0.95	2.87	6.40	57.93	62.00	41.50	55.33	56.28
306+09	21.69	8.96	197.13	11.80	0.91	1.97	6.36	7.72	59.90	62.18	45.04	54.00	55.97
305+79	23.63	9.49	197.13	10.92	0.83	1.78	5.79	6.14	58.80	59.99	43.94	53.43	55.21
305+51	21.84	7.43	197.13	14.61	1.32	3.22	7.48	10.16	57.99	61.99	43.74	51.17	54.39
305+23	24.74	7.47	197.13	12.87	1.09	2.51	8.90	9.78	58.00	59.98	42.18	49.65	52.16
304+92	20.95	9.33	98.18	12.07	2.01	2.16	10.48	8.38	58.17	58.09	39.37	48.70	50.86
304+84	21.70	10.77	98.18	11.04	1.81	1.84	10.13	8.37	58.00	58.05	38.00	48.77	50.61
304+64	19.77	9.31	98.18	12.98	2.29	2.47	11.41	8.90	58.02	57.80	38.44	47.75	50.22
304+44	21.03	7.63	98.18	14.18	2.65	2.88	2.92	8.17	48.21	56.10	38.98	46.61	49.49
304+21	23.36	7.87	98.18	11.52	1.79	1.86	1.82	7.35	46.67	54.00	37.88	45.75	47.61
303+93	26.00	9.24	98.18	10.03	1.51	1.47	1.81	8.93	46.36	55.00	36.07	45.31	46.78
303+59	20.03	10.19	98.18	11.27	1.77	1.79	0.48	8.45	44.21	53.95	34.42	44.61	46.40
303+19	18.15	10.98	98.18	12.11	2.05	2.11	0.08	5.34	42.83	50.15	32.80	43.78	45.89

Superelevation Calculation for Proposed Condition (n=0.03): 100-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	10.54	197.13	8.34	0.61	1.06	1.70	3.46	57.64	60.00	45.70	56.24	57.30
306+46	30.21	11.14	197.13	8.72	0.64	1.17	2.37	1.76	57.97	58.00	44.78	55.92	57.09
306+29	25.72	14.29	197.13	8.67	0.66	1.14	2.47	5.88	57.93	62.00	41.50	55.79	56.93
306+09	21.69	9.34	197.13	11.82	0.93	2.21	5.99	7.33	59.90	62.18	45.04	54.38	56.59
305+79	23.63	10.06	197.13	10.99	0.87	1.78	5.23	5.55	58.80	59.99	43.94	54.00	55.78
305+51	21.84	8.01	197.13	14.12	1.27	3.25	6.87	9.60	57.99	61.99	43.74	51.75	55.00
305+23	24.74	7.42	197.13	15.33	1.58	3.68	9.19	9.59	58.00	59.98	42.18	49.60	53.28
304+92	20.95	9.71	98.18	13.20	2.50	2.60	10.34	7.76	58.17	58.09	39.37	49.08	51.68
304+84	21.70	10.98	98.18	12.78	2.52	2.48	10.28	7.81	58.00	58.05	38.00	48.98	51.46
304+64	19.77	9.48	98.18	14.36	2.91	3.06	11.55	8.43	58.02	57.80	38.44	47.92	50.98
304+44	21.03	8.44	98.18	14.03	2.70	2.75	2.14	7.33	48.21	56.10	38.98	47.42	50.17
304+21	23.36	8.51	98.18	13.54	2.65	2.61	1.61	6.28	46.67	54.00	37.88	46.39	49.00
303+93	26.00	10.08	98.18	10.70	1.80	1.65	1.11	7.95	46.36	55.00	36.07	46.15	47.80
303+59	20.03	10.98	98.18	12.05	2.13	2.01	-0.13	7.48	44.21	53.95	34.42	45.40	47.41
303+19	18.15	11.67	98.18	13.07	2.52	2.41	-0.38	4.42	42.83	50.15	32.80	44.47	46.88

Superelevation Calculation for Proposed Condition (n=0.05): 100-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	10.55	197.13	8.42	0.62	1.08	1.70	3.44	57.64	60.00	45.70	56.25	57.33
306+46	30.21	11.09	197.13	9.03	0.69	1.23	2.45	1.78	57.97	58.00	44.78	55.87	57.10
306+29	25.72	14.24	197.13	8.84	0.68	1.19	2.53	5.92	57.93	62.00	41.50	55.74	56.93
306+09	21.69	9.34	197.13	12.34	1.02	2.20	6.03	7.29	59.90	62.18	45.04	54.38	56.58
305+79	23.63	9.87	197.13	11.69	0.98	1.97	5.48	5.69	58.80	59.99	43.94	53.81	55.78
305+51	21.84	8.06	197.13	14.71	1.39	3.19	6.88	9.49	57.99	61.99	43.74	51.80	54.99
305+23	24.74	8.09	197.13	14.24	1.40	3.03	8.43	9.01	58.00	59.98	42.18	50.27	53.30
304+92	20.95	9.92	98.18	13.19	2.52	2.54	10.14	7.54	58.17	58.09	39.37	49.29	51.83
304+84	21.70	11.11	98.18	13.18	2.71	2.53	10.25	7.58	58.00	58.05	38.00	49.11	51.64
304+64	19.77	9.40	98.18	15.01	3.21	3.27	11.78	8.36	58.02	57.80	38.44	47.84	51.11
304+44	21.03	8.44	98.18	14.03	2.70	2.75	2.14	7.33	48.21	56.10	38.98	47.42	50.17
304+21	23.36	8.51	98.18	13.54	2.65	2.61	1.61	6.28	46.67	54.00	37.88	46.39	49.00
303+93	26.00	10.08	98.18	10.70	1.80	1.65	1.11	7.95	46.36	55.00	36.07	46.15	47.80
303+59	20.03	10.98	98.18	12.05	2.13	2.01	-0.13	7.48	44.21	53.95	34.42	45.40	47.41
303+19	18.15	11.67	98.18	13.07	2.52	2.41	-0.38	4.42	42.83	50.15	32.80	44.47	46.88

Superelevation Calculation for Existing Condition: 100-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	11.08	197.13	8.03	0.57	1.00	1.15	2.93	57.64	60.00	45.70	56.78	57.78
306+46	30.21	11.53	197.13	8.90	0.68	1.21	2.00	1.35	57.97	58.00	44.78	56.31	57.52
306+29	25.72	14.71	197.13	8.62	0.66	1.14	2.05	5.46	57.93	62.00	41.50	56.21	57.35
306+09	21.69	9.89	197.13	12.29	1.04	2.10	5.49	6.73	59.90	62.18	45.04	54.93	57.03
305+79	23.63	10.42	197.13	11.56	0.98	1.97	4.93	5.14	58.80	59.99	43.94	54.36	56.33
305+51	21.84	8.27	197.13	15.31	1.53	3.50	6.75	9.21	57.99	61.99	43.74	52.01	55.51
305+23	24.74	8.24	197.13	13.63	1.28	2.80	8.22	8.92	58.00	59.98	42.18	50.42	53.22
304+92	20.95	10.04	98.18	13.09	2.50	2.53	10.01	7.43	58.17	58.09	39.37	49.41	51.94
304+84	21.70	11.47	98.18	12.11	2.28	2.21	9.67	7.44	58.00	58.05	38.00	49.47	51.68
304+64	19.77	9.70	98.18	14.55	3.03	3.08	11.39	8.14	58.02	57.80	38.44	48.14	51.22
304+44	21.03	8.49	98.18	14.66	2.99	3.02	2.24	7.13	48.21	56.10	38.98	47.47	50.49
304+21	23.36	8.70	98.18	12.06	2.07	2.01	1.12	6.39	46.67	54.00	37.88	46.58	48.59
303+93	26.00	10.08	98.18	10.70	1.80	1.65	1.11	7.95	46.36	55.00	36.07	46.15	47.80
303+59	20.03	10.98	98.18	12.05	2.13	2.01	-0.13	7.48	44.21	53.95	34.42	45.40	47.41
303+19	18.15	11.67	98.18	13.07	2.52	2.41	-0.38	4.42	42.83	50.15	32.80	44.47	46.88

Superelevation Calculation for Proposed Condition (n=0.03): USACE 100-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	12.66	197.13	9.52	0.86	1.38	-0.29	1.21	57.64	60.00	45.70	58.36	59.74
306+46	30.21	13.24	197.13	9.88	0.90	1.51	0.40	-0.47	57.97	58.00	44.78	58.02	59.53
306+29	25.72	16.26	197.13	10.27	1.00	1.60	0.67	3.74	57.93	62.00	41.50	57.76	59.36
306+09	21.69	11.28	197.13	12.84	1.21	2.67	4.19	5.25	59.90	62.18	45.04	56.32	58.99
305+79	23.63	12.14	197.13	12.02	1.14	2.11	3.29	3.33	58.80	59.99	43.94	56.08	58.19
305+51	21.84	9.80	197.13	15.16	1.62	3.86	5.26	7.64	57.99	61.99	43.74	53.54	57.40
305+23	24.74	8.97	197.13	17.05	2.15	4.60	7.93	7.75	58.00	59.98	42.18	51.15	55.75
304+92	20.95	11.11	98.18	15.67	3.97	3.64	9.68	5.62	58.17	58.09	39.37	50.48	54.12
304+84	21.70	12.36	98.18	15.18	3.96	3.50	9.62	5.71	58.00	58.05	38.00	50.36	53.86
304+64	19.77	11.15	98.18	16.07	4.11	3.78	10.48	6.15	58.02	57.80	38.44	49.59	53.37
304+44	21.03	9.24	98.18	17.34	4.65	4.14	2.31	5.56	48.21	56.10	38.98	48.22	52.36
304+21	23.36	10.40	98.18	14.40	3.34	2.79	0.06	4.05	46.67	54.00	37.88	48.28	51.07
303+93	26.00	11.86	98.18	12.37	2.67	2.17	-0.24	5.74	46.36	55.00	36.07	47.93	50.10
303+59	20.03	12.75	98.18	13.78	3.11	2.53	-1.40	5.22	44.21	53.95	34.42	47.17	49.70
303+19	18.15	13.02	98.18	15.51	3.97	3.26	-1.01	2.34	42.83	50.15	32.80	45.82	49.08

Superelevation Calculation for Proposed Condition (n=0.05): USACE 100-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	12.59	197.13	9.71	0.89	1.44	-0.20	1.26	57.64	60.00	45.70	58.29	59.73
306+46	30.21	13.07	197.13	10.40	0.99	1.62	0.62	-0.35	57.97	58.00	44.78	57.85	59.47
306+29	25.72	16.07	197.13	10.65	1.07	1.71	0.90	3.89	57.93	62.00	41.50	57.57	59.28
306+09	21.69	11.18	197.13	13.77	1.40	2.68	4.38	5.26	59.90	62.18	45.04	56.22	58.90
305+79	23.63	11.71	197.13	13.23	1.37	2.47	3.84	3.65	58.80	59.99	43.94	55.65	58.12
305+51	21.84	9.84	197.13	16.10	1.85	3.75	5.33	7.48	57.99	61.99	43.74	53.58	57.33
305+23	24.74	9.85	197.13	15.81	1.90	3.68	6.92	7.00	58.00	59.98	42.18	52.03	55.71
304+92	20.95	11.53	98.18	15.44	3.91	3.42	9.23	5.23	58.17	58.09	39.37	50.90	54.32
304+84	21.70	12.43	98.18	15.95	4.47	3.65	9.80	5.38	58.00	58.05	38.00	50.43	54.08
304+64	19.77	11.27	98.18	16.56	4.45	3.85	10.53	5.87	58.02	57.80	38.44	49.71	53.56
304+44	21.03	9.04	98.18	17.88	4.96	4.42	2.67	5.60	48.21	56.10	38.98	48.02	52.44
304+21	23.36	10.40	98.18	14.40	3.34	2.79	0.06	4.05	46.67	54.00	37.88	48.28	51.07
303+93	26.00	11.86	98.18	12.37	2.67	2.17	-0.24	5.74	46.36	55.00	36.07	47.93	50.10
303+59	20.03	12.75	98.18	13.78	3.11	2.53	-1.40	5.22	44.21	53.95	34.42	47.17	49.70
303+19	18.15	13.02	98.18	15.51	3.97	3.26	-1.01	2.34	42.83	50.15	32.80	45.82	49.08

Superelevation Calculation for Existing Condition: USACE 100-Year Flood

River Station	Channel Bottom Width	Normal Depth	Radius of Curve	Vel Chnl	Superelevations Between Channel Sides	Maximum Difference Between WS and EG	L Bank Freeboard	R Bank Freeboard	L Bank El	R Bank El	Min Ch El	W.S. Elev	E.G. Elev
	b (ft)	d (ft)	R (ft)	V (ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
306+62	33.12	13.35	197.13	9.21	0.82	1.30	-1.00	0.54	57.64	60.00	45.70	59.05	60.35
306+46	30.21	13.65	197.13	10.28	0.99	1.60	0.04	-0.93	57.97	58.00	44.78	58.43	60.03
306+29	25.72	16.73	197.13	10.37	1.04	1.65	0.22	3.25	57.93	62.00	41.50	58.23	59.88
306+09	21.69	12.10	197.13	13.40	1.38	2.41	3.45	4.35	59.90	62.18	45.04	57.14	59.55
305+79	23.63	12.56	197.13	12.99	1.37	2.45	2.99	2.80	58.80	59.99	43.94	56.50	58.95
305+51	21.84	10.16	197.13	16.95	2.10	4.21	5.14	7.04	57.99	61.99	43.74	53.90	58.11
305+23	24.74	10.10	197.13	15.18	1.76	3.41	6.60	6.82	58.00	59.98	42.18	52.28	55.69
304+92	20.95	11.59	98.18	15.55	3.99	3.52	9.20	5.14	58.17	58.09	39.37	50.96	54.48
304+84	21.70	12.99	98.18	14.65	3.75	3.19	8.88	5.18	58.00	58.05	38.00	50.99	54.18
304+64	19.77	11.32	98.18	16.69	4.54	3.92	10.53	5.77	58.02	57.80	38.44	49.76	53.68
304+44	21.03	9.70	98.18	17.26	4.70	4.07	1.88	5.07	48.21	56.10	38.98	48.68	52.75
304+21	23.36	10.63	98.18	12.93	2.64	2.19	-0.52	4.17	46.67	54.00	37.88	48.51	50.70
303+93	26.00	11.86	98.18	12.37	2.67	2.17	-0.24	5.74	46.36	55.00	36.07	47.93	50.10
303+59	20.03	12.75	98.18	13.78	3.11	2.53	-1.40	5.22	44.21	53.95	34.42	47.17	49.70
303+19	18.15	13.02	98.18	15.51	3.97	3.26	-1.01	2.34	42.83	50.15	32.80	45.82	49.08

Draft

Hydrologic and Hydraulics Report

Aiea Stream Erosion Control

in the Vicinity of the Interstate H-1 Freeway

Aiea, Hawaii

STATE OF HAWAII

DEPARTMENT OF TRANSPORTATION

HIGHWAYS DIVISION

March 16, 2010

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Executive Summary

The State of Hawaii Department of Transportation (HDOT) is proposing to mitigate erosion problems occurring along Aiea Stream immediately downstream of the Interstate H-1 Freeway. In particular, severe erosion is prevalent on the western (Ewa) bank of the stream at the Aiea Shopping Center. The eroded streambank requires protection, stabilization and strengthening to prevent further undercutting and potential damage to private property. The proposed project involves stabilization of approximately 200 linear feet of degraded streambank through use of soil nailing with shotcrete finishing along the western streambank downstream of the existing H-1 culvert outlet.

An updated hydrologic analysis was conducted using the USGS regression method, stream gage analysis and NRCS TR-20 model. The results were compared with previous hydrologic analyses performed for the City and County in 1977. The results of the updated hydrologic analysis were used as the input for the hydraulics analysis.

The hydraulic analysis was performed using USACE HEC-RAS 4.0 to evaluate the existing conditions and to evaluate the proposed shotcrete wall design.

The hydraulic study shows that with a roughened shotcrete wall finishing, the proposed 200 feet of shotcrete wall along the Aiea Shopping Center can be constructed to protect the bank erosion without increasing flood levels, while maintaining current velocities and shear stress levels in the Aiea Stream.

Streambank erosion will be further minimized by redirecting the existing 42-inch diameter corrugated drainage pipe which is presently perpendicular to the stream flow. The 42-inch pipe will be made parallel to the stream's direction. This 42-inch pipe carries storm water from portions of H-1 and the cul-de-sac at the end of Laka Place to a

discharge point along the eastern (Diamond Head) bank of the stream approximately 125 feet below the outlet of the H-1 double cell box culvert.

1. Introduction

1.1. Background

The Aiea Stream is an intermittent stream tributary to Pearl Harbor. The stream originates in preserved forest land (Keaiwa Heiau State Recreation Area) at its headwaters and traverses through urbanized areas along Aiea Heights Drive, the H-1 Corridor, Moanalua Road, and Kamehameha Highway before entering into Pearl Harbor. The proposed stream stabilization project addresses severe erosion along the west bank of Aiea Stream immediately downstream of the H-1 corridor (Figure 1). Further erosion will result in the loss of ground support for on-grade concrete slabs supporting existing equipment, undermining of perimeter fence footings and walkway concrete slabs, and loss of soil cover on existing building foundations.

1.2. Project Descriptions

The purpose of the proposed project is to remediate erosion problems occurring along the west bank of Aiea Stream below the outlet of an Interstate Route H-1 double barrel (15' x 12' each) box culvert. The proposed project will include streambank stabilization using soil nails with shotcrete facing. The proposed project concept will protect the existing bank from continuing erosion, and includes realignment of an existing HDOT 42-inch drainage pipe, installation of fencing and removal of existing large trees.

Soil nailing with shotcrete facing is an effective technique for stabilizing streambanks. This ground reinforcement method uses steel tendons which are drilled and grouted into the for ground support. The shotcrete facing is applied on top of the soil nail anchors and provides a hardened structural protection above the raw soil of the streambank. Additionally, use of the shotcrete facing lowers the streambank roughness and allows for

a slight increase in the conveyance efficiency of the stream. Many architectural options are available to provide aesthetically pleasing permanent wall facings. The proposed project concept involves use of rock sculpture facing to provide a natural facade with aesthetic appeal to the stream while providing hardened structural protection to the streambank.

Figure 1. Aiea Stream Project Location Map

2. Hydrology

The objective of the hydrologic study is to estimate the existing condition of the Aiea Stream peak discharges for the 2-, 10-, and 100-year returns in the vicinity of the Aiea Shopping Center. The documented discharges will be used in the development of existing condition hydraulic models and evaluation of the proposed streambank stabilization design.

2.1. Watershed Description

The Aiea Stream stabilization project is located along the Aiea Stream immediately below the Interstate H-1 crossing in the City and County of Honolulu, Hawaii. The project is located along the west streambank adjacent to the Aiea Shopping Center. The major features of the watershed tributary in the proximity of the project site include the Interstate H-1 Freeway and the Aiea residential neighborhood.

The Aiea Stream drainage area tributary to the project location is 1.3 square miles (834 acres), 3.47 miles in length and only 0.65 miles wide at its widest point. At the project location Aiea Stream is a second order stream.

The dominant land use in the watershed is mixed forest primarily from the conservation forest land. The impervious area within the Aiea Stream watershed is approximately 14 percent. A breakdown of the documented land uses within the Aiea Stream watershed is presented in Table 1.

Table 1. Land Use Distribution in the Aiea Stream Watershed.

Land Use	Area (Acres)	Percentage of Total Area
Residential	239.6	27.4%
Commercial	7.9	0.9%
Agricultural	0.0	0.0%
Institutional	33.1	3.8%
Industrial	10.8	1.2%
Mixed forest	582.5	66.7%

The dominant soil type within the watershed is Type D hydrologic soils designated as Rock Land and Rough Mountainous Land by the NRCS. Other soil types in the watershed are Type B and Type C, which are coarse texture soil and moderately fine texture soil respectively. The breakdown of the hydrologic soil groups within the Aiea Stream watershed are presented in Table 2.

Table 2. Hydrologic Soils Distribution in the Aiea Stream Watershed.

	Hydrologic Soils Group			
Area	A	B	C	D
Acres	0	104	246	524
Percent	0.0%	11.9%	28.1%	59.9%

Based on the land uses and hydrologic soil groupings, the weighted Curve Number for the Aiea Stream watershed was determined to be 77.

2.2. Previous Studies

The lower reach of Aiea Stream has been the focus of multiple watershed and flooding studies since the 1970's. Flood studies relevant to the Aiea Stream stabilization project include the 1972 and 1977 Environmental Impact Statement (EIS) prepared for the City

and County of Honolulu Department of Public Works and the 2004 update to the Flood Insurance Study (FIS) prepared by the Federal Emergency Management Agency (FEMA).

The 1972 and 1977 EIS studies were prepared for the purpose of designing concrete flood control channels along Aiea Stream to efficiently convey high flow storm discharges while minimizing flood impacts to adjacent properties. The 1977 EIS documented four phases of flood control projects along Aiea Stream. Only the first phase of the project from Moanalua Road to Pearl Harbor was completed. The 1972 EIS was prepared by the U.S. Army Corps of Engineers. The information presented herein for the 1972 EIS was taken from references presented in the 1977 EIS. The peak discharges from the 1972 EIS are presented in Table 3.

Table 3. 1972 U.S. Army Corps of Engineers EIS Peak Discharges

Return Period	1972 EIS Peak Discharge of Aiea Stream
(Yrs)	(cfs)
50	2,950
100	3,850

The results of the 1972 EIS are documented for the east basin of Aiea Stream above Moanalua Road. However, direct comparison of the discharges to the current study is difficult without more detailed information on the type of hydrologic study performed and the drainage area size tributary to the study location.

The 1977 EIS study performed the hydrologic computations using Plate 6 of 1980 City and County of Honolulu Storm Drain Standard. The 1977 study documented a watershed drainage area of 1.3 square miles upstream of the study location. The result of the 1977 EIS study is presented in Table 4.

Table 4. 1977 EIS Peak Discharges

Return Period	1977 EIS Peak Discharge of Aiea Stream
Yr	(cfs)
100-Year	3,500

Hydrologic computations for Aiea Stream were performed for the FEMA FIS and are included in the updated 2004 FIS. However, the date of when the hydrologic analysis was performed is not noted in the latest release of the FIS. The FEMA FIS utilized the USGS WRI 80-45 (1974) statistical report for the development of the discharges along Aiea Stream. The FEMA report documents discharges at two locations along Aiea Stream: one at Moanalua Road and one near Aiea Heights Drive. The reported discharges from the FEMA FIS are reported in Table 5. Additionally, Table 5 presents the FIS discharges scaled to the Aiea Stream stabilization project site based on watershed areas.

Table 5. FEMA FIS Aiea Stream Discharges.

Return Period	at Moanalua Road 1.38 sq. mi.	Near Aiea Heights Road 1.05 sq. mi.	Scaled Moanalua Road Discharges at Aiea project site	Scaled Aiea Heights Discharges at Aiea project site
(Yrs)	(cfs)	(cfs)	(cfs)	(cfs)
10	1140	910	1074	1127
50	2130	1710	2007	2117
100	2660	2140	2506	2650

2.3. Hydrologic Analysis

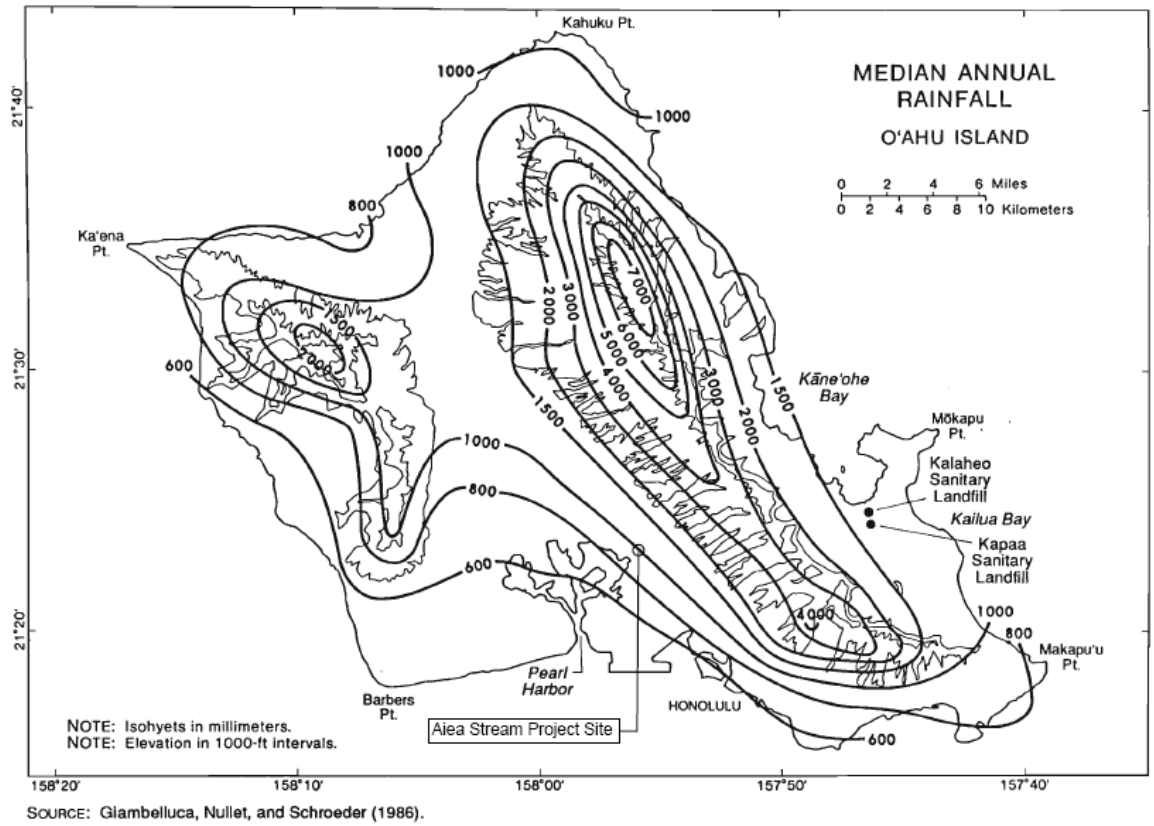
2.3.1. Regression Analysis

Regression analyses are methods for determining peak discharges for ungaged stream basins based upon documented peak discharges for other streams within the same

physiographic area. Use of regression equations for development of peak stream discharges for an ungaged basin can provide reliable results as long as the ungaged watershed falls within the development parameters of the utilized regression equation.

Two separate regression equations were evaluated in the hydrologic analysis of the Aiea Stream. The regression equations evaluated are the USGS Regression Equation developed by Wong (1994) and the Plate 6 (Rules Relating to Storm Drainage Standards, City and County of Honolulu) peak discharge chart.

The USGS regression equations were developed in the early 1990's and are based upon 72 stream gaging stations with gage records ranging from 11 to 72 years. The USGS Regression Equations were developed for three physiographic areas on the island of Oahu. The Aiea Stream is located in the Region 1 – Leeward area which extends from the Koolau Range to the western edge of the island and north to an approximate latitude of 21o30'25". The USGS regression equations for the Leeward area were developed for watersheds ranging in size from 0.60 to 45.7 square miles with urban cover ranging from 0 to 32 percent. The Aiea Stream watershed falls within these development parameters. The USGS regression equations for Region 1 are based on drainage area and median annual precipitation. The median annual precipitation for the Aiea Stream watershed was determined from the isohyetal map of Oahu shown in Figure 2. The median annual precipitation was determined to be 39.37 inches (1,000 mm).



SOURCE: Giambelluca, Nullet, and Schroeder (1986).

Figure 2. Median Annual Precipitation Isohyetal Map of Oahu.

The results of the USGS Regression Analysis are presented in Table 6.

Table 6. USGS Regression Analysis Results for Aiea Stream.

Return Period	Aiea Stream Peak Discharge Using Regression Analysis
(yrs)	(cfs)
2.0	203.35
5.0	522.20
10.0	852.10
25.0	1413.27
50.0	1944.93
100.0	2565.38

The Plate 6 analysis is similar to the USGS regression equations in that it divides the island of Oahu into three physiographic areas and is based upon USGS stream gaging records. The three physiographic areas presented in Plate 6 are different from those presented in the USGS analysis. Additionally, the basis of the regression curves is slightly different from the USGS equations which correlated the peak discharge to drainage and median annual precipitation, whereas Plate 6 correlates the peak discharge only to drainage area. The Plate 6 methodology was developed and revised in the 1980's and is based upon the USGS stream gage sites with 10 to 60 years of data.

The Aiea Stream watershed falls within the Group B area on Plate 6 which covers most of the areas of Oahu between the Koolau Range ridge line and the Waianae Range ridge line. The result of the Plate 6 analysis is presented in Table 7.

Table 7. Plate 6 Analysis Results.

Return Period	Peak Discharge Using Plate 6
(yrs)	(cfs)
100-Year	3,600

2.3.2. Stream Gage Analysis

The Aiea Stream does not contain any USGS stream gages nor has any readily available records of peak flows for use in a stream gage statistical analysis. However, two adjacent watersheds (Kalauao and Halawa) each have USGS stream gages with more than 40 years of records. Since the adjacent watersheds have similar land uses and soils, use of the discharge records for evaluation of the Aiea Stream is appropriate.

The Kalauao watershed is located to the north of the Aiea watershed. The Kalauao watershed area is 2.59 square miles and is longer and narrower than the Aiea watershed. The Kalauao Stream originates as a single headwater stream and remains a 1st order

stream to the USGS stream gage. The Kalauao stream gage has 43 years of peak discharge data for the stream. A statistical analysis of the Kalauao peak discharge data was performed using the Gumbel Type I distribution. After determination of the return period discharges through use of the Gumbel distribution, the discharges were modified and scaled for use in evaluating the Aiea Stream project site following the guidance provided in the USGS National Flood Frequency Program (USGS NFFP) publication (Wong, 1994). The results of the Gumbel gage analysis and the scaled discharges are presented in Table 8.

Table 8. Statistical Analysis Results from the Kalauao Stream Gage.

Return Period	Kalauao Stream Gage Analysis Peak Discharges	Scaled Aiea Stream Peak Discharges
(yrs)	(cfs)	(cfs)
2	969	440
5	1472	688
10	1805	863
25	2225	1115
50	2537	1330
100	2847	1565

The North Halawa watershed is located to the south of the Aiea watershed. The North Halawa watershed area is 3.45 square miles at the USGS stream gage location. The North Halawa watershed is similar in shape to the Aiea watershed. The North Halawa Stream tributary to the USGS gage originates as three smaller headwater streams and is a 2nd order stream at the gage location similar to the Aiea Stream at the project site. The stream gage at the North Halawa gaging station has a 58-year record. A statistical analysis of the North Halawa Stream gage data was performed using a Log-Pearson Type II distribution. Similar to the Kalauao analysis, the discharges resulting from the Log-

Pearson Type II statistical analysis were modified and scaled for the Aiea Stream project site. The results of the Log-Pearson Type II analysis for the North Halawa gaging station are presented in Table 9.

Table 9. Statistical Analysis Results from the North Halawa Stream Gage.

Return Period	North Halawa Stream Gage Analysis Peak Discharges	Scaled Aiea Stream Peak Discharges
(yrs)	(cfs)	(cfs)
2	1005	355
5	2077	731
10	3099	1076
25	4825	1648
50	6480	2188
100	8500	2835

2.3.3. TR-20 Analysis

Each of the hydrologic methodologies investigated thus far provide approximations of the peak discharges for the Aiea Stream. However, each of these methods predicts peak discharges based upon similar watersheds and not the individual physical attributes of the Aiea watershed. This gap is bridged in the hydrologic analysis through the incorporation of a TR-20 model study supplemented by the regression and statistical analyses.

The TR-20 hydrologic model develops peak discharge data based upon watershed land use, soil type, watershed shape, topography, drainage network, and precipitation. The results of the previously discussed regression analysis and stream gage statistical analysis are utilized to calibrate the results of the TR-20. Calibration of the model with data from the regression and statistical analyses is important as the model inputs can vary with engineering judgment. A calibrated TR-20 that is in good agreement with reliable regression and statistical gage analyses provides a solid method for evaluation of peak

discharges of an ungaged basin. This methodology allows for the combination of a system based on the physical attributes of the watershed (TR-20) and historical records of stream flows in the region (regression and statistical gage analysis).

The TR-20 model for the Aiea watershed was developed based upon the documented 1.3 square miles of watershed area, the curve number of 77 and a time of concentration of 0.78 hours. Supporting computations for each of these values can be found in Appendices. The precipitation data utilized for the model were taken from the NOAA Atlas 14 publication and modeled using the NRCS Type I storm distribution. The results of the TR-20 modeling are presented in Table 10.

Table 10. Peak Discharges for the Aiea Stream from the TR-20 Model

Return Period	Aiea Stream Peak Discharge
(yrs)	(cfs)
2	241
5	454
10	639
25	1916
50	2321
100	2743

2.4. Hydrologic Analysis Results

2.4.1. Discussions

A summary of results from the various hydrologic analyses performed by PB and by others are presented in Figure 3.

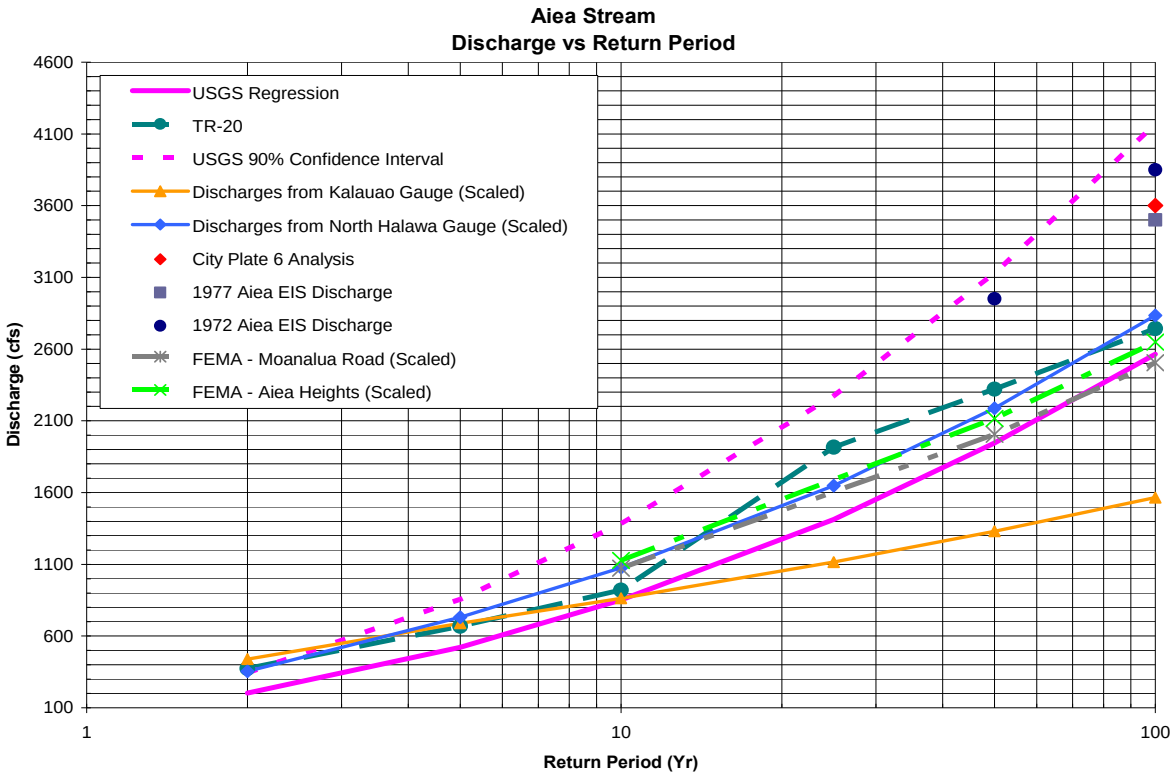


Figure 3. Graph of the Peak Discharge Values vs. Return Period for Aiea Stream.

An analysis of the various results obtained from previous studies, the regression studies, the statistical gage analysis and the TR-20 modeling were made:

- The data presented from the 1972 EIS was developed for an unknown basin size using unknown hydrologic methodologies. Since substantiation of these discharges is not possible with the current information, they were not relied upon for determination of flood discharges for the Aiea Stream stabilization project.

- The 1977 EIS used the same methodology as the current Plate 6 analysis. The difference in the discharge values between the 1977 data and the Plate 6 data is likely attributable to updates of the Plate 6 curves in the early 1980's. Based upon the results of the statistical stream gage analyses for North Halawa and Kalauao Streams, the resultant peak discharges from the 1977 EIS and the Plate 6 analysis

appear to conservatively over-predict the flooding conditions in the Aiea stream area. Additionally, the Plate 6 methodology only allows for prediction of the 100-year peak discharge and does not allow for evaluation of lower return period storms such as the 2-year and 10-year that are important for evaluation of the stream stabilization design.

- Use of the Kalauao Stream gage for evaluation of the Aiea Stream may not be appropriate. Kalauao Stream is a 1st order stream with a comparatively long narrow watershed. A long narrow watershed would theoretically be expected to produce lower peak discharges than rounder watersheds of comparable size. This is reflected in the results of the Kalauao Stream gage analysis as compared to the Halawa gage and the USGS regression analysis.

2.4.2. Conclusions

The results of the North Halawa Stream gage analysis and the USGS regression equation were both utilized to calibrate the TR-20 model of the Aiea Stream watershed. The resultant TR-20 model provides a combination of the physical characteristics of the Aiea Stream watershed combined with historical stream gaging records for the area. The FEMA FIS discharge also provides good agreement with the TR-20 data. The results of the TR-20 model compared with the USGS, the North Halawa watershed calibration data, and the FEMA FIS data are presented in Figure 4.

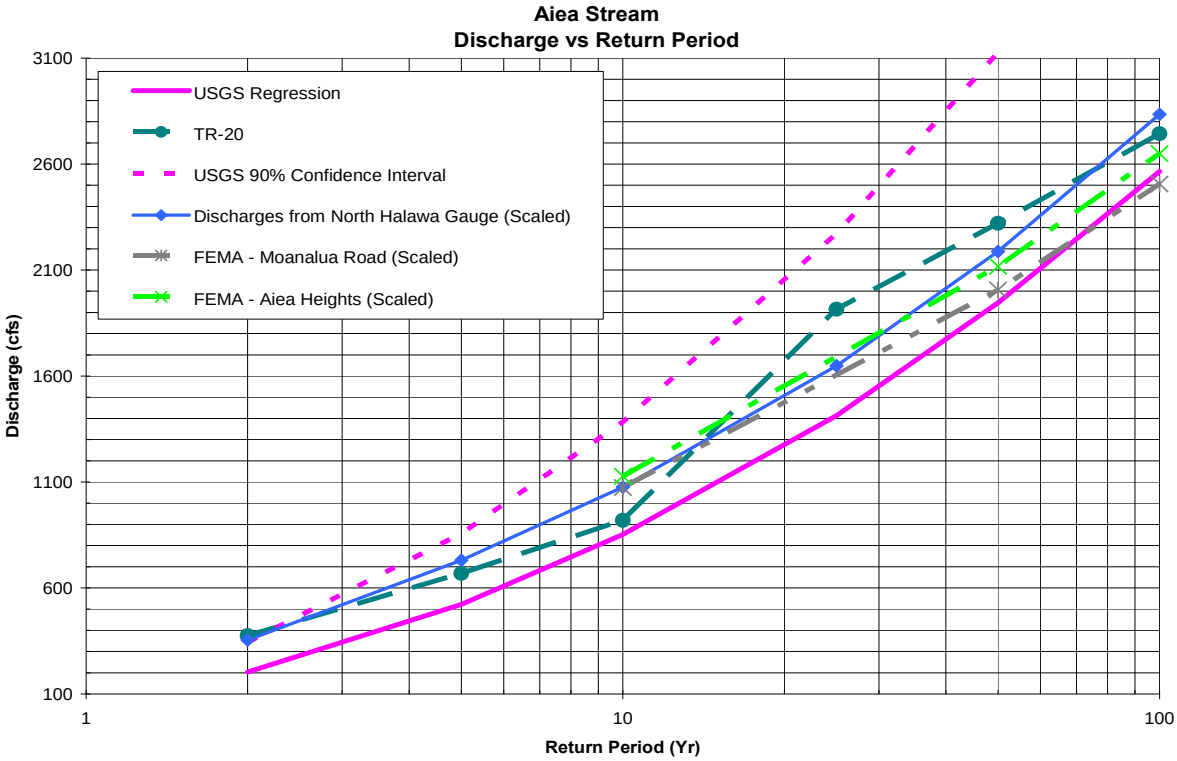


Figure 4. Aiea Stream TR-20 Model Results with Calibration Data.

The results of the calibrated TR-20 model will be utilized for hydraulic modeling of the Aiea Stream and evaluation of the proposed stream stabilization design. The design discharges determined for the Aiea Stream are presented in Table 11.

Table 11. Design Discharges for the Aiea Stream Stabilization Project.

Return Period	Aiea Stream Peak Discharges for Design
(yrs)	(cfs)
2	241
5	454
10	639
25	1916
50	2321
100	2743

3. Hydraulics

3.1. Project Area Description

Aiea Stream is an intermittent, 2nd order stream that flows from the Keaiwa Heiau State Recreation Area at its headwaters and empties into Pearl Harbor at the northwest corner of Pearl Harbor. The banks of Aiea Stream in the project area are composed of silty clay soils with gravel. The stream bed is composed of boulders, cobbles and gravels. The 1977 EIS documents that flood control projects below Moanalua Road have been completed. However, the area upstream of Moanalua Road, including the project site, is subject to flooding and erosion. In addition, the streambanks are lower at the location along the south bank, opposite of the shopping center, where some private retaining walls are only 3 to 4 feet high. These areas are subject to shallow flooding as documented in the 2004 FEMA FIS report.

3.2. Study Methodology

The hydraulic study presented herein was developed for the purpose of modeling existing conditions in the Aiea Stream and for the hydraulic evaluation of the proposed streambank stabilization design. The hydraulic analysis was conducted along the stream reach where a shotcrete wall is proposed (Figure 5). The total length of the modeled stream reach is approximately 1,120 feet. The study area starts from approximately 150 feet upstream of Ulune Street to approximately 300 feet upstream of Moanalua Road. The hydraulics analysis for the site was performed using HEC-RAS Version 4.0. Both existing and proposed stream conditions were developed based on a model of 37 cross-sections and 2 culvert crossings. All existing cross-sections and culvert opening geometry were from field surveyed topographic data and were derived from a digital

elevation model of the stream channel. The proposed conditions are simulated for the 200 feet of the existing west bank with proposed shotcrete wall in the model.

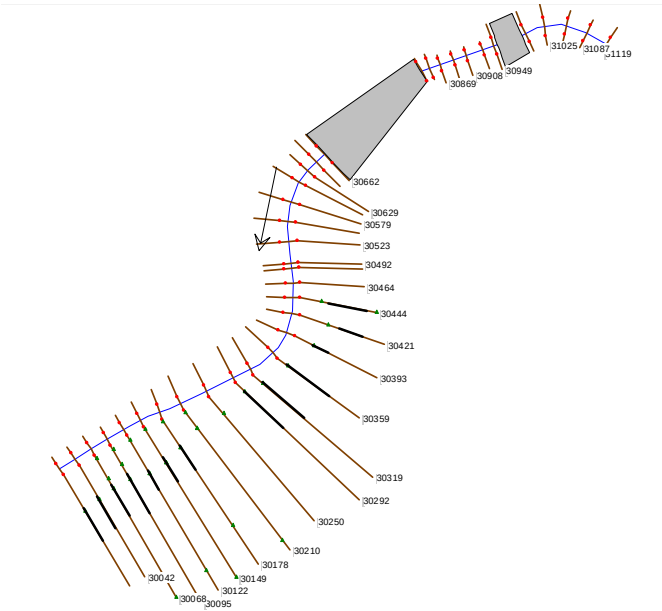


Figure 5. Hydraulic Model Layout (with stations labeled).

The Aiea Stream discharges were based on hydrologic analysis as described in the previous chapter. Simulation results were compared for 2-, 5-, 10-, 25-, 50-, and 100-year peak discharges. In this report, only the result for 100-year peak discharge is discussed. Results for other scenarios are available in the appendices. The roughness coefficient and locations of the proposed shotcrete wall in the model were adjusted accordingly in order to alleviate erosion problems.

3.3. Hydraulic Analysis

3.3.1. Existing Condition

The hydraulic study indicates that the average stream gradient is relatively steep with a slope of about 0.033 ft./ft., which produces an average velocity of 13 feet per second in

the stream segment studied for a 100-year flow. Modeling of the H-1 culverts shows that a hydraulic jump is expected to occur inside the culvert barrels (Figure 6). The average flow velocity at the inlet of the H-1 culvert is 30 feet per second due to the steep ogee type inlet structure as shown in Figure 7. The culvert barrels are in good condition but contain some debris (Figure 7).

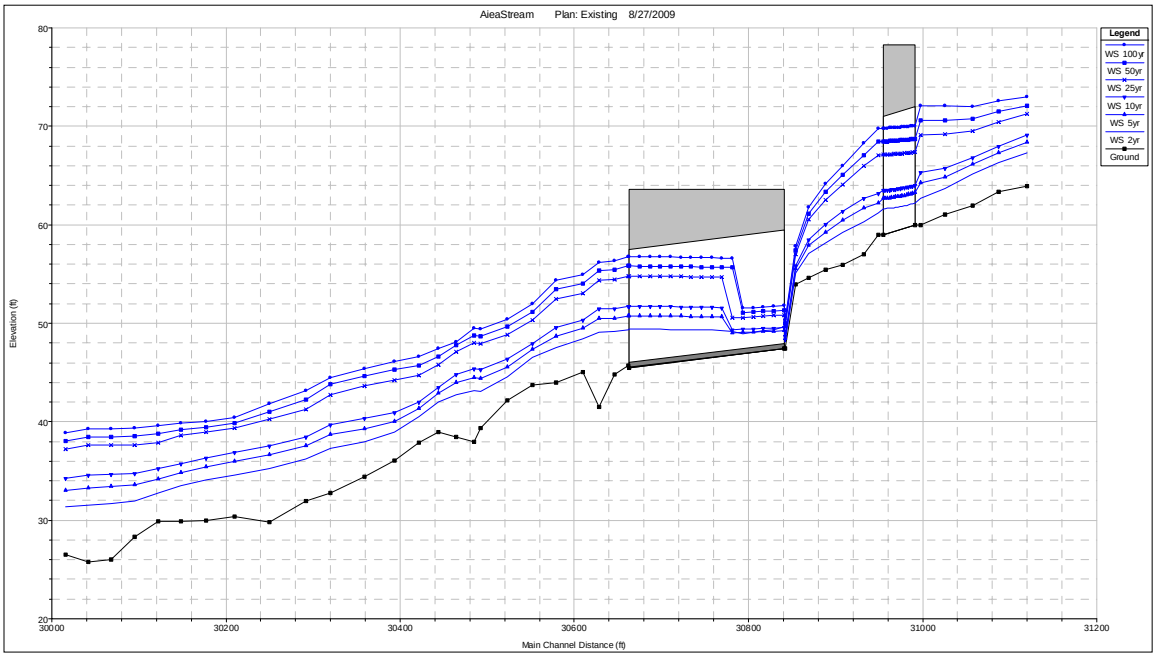


Figure 6. Water Surface Profile for Existing Condition.

Figure 7. H-1 Freeway Culvert Inlet and Interior View.

Due to the steepness of the stream channel and the H-1 culvert entrance, the flow velocity is relatively high at the project location. At the Aiea Shopping Center, the 100-year channel flow velocity is nearly 11 feet per second at Station 305+51 which is located at the corner of the Aiea Shopping Center building where large air conditioning units are located. Severe erosion has been observed along the right streambank at this location as shown in Figure 8. Under the current conditions the streambank exhibits evidence of progressive bank erosion. Site inspections show erosion at the shopping center property. Chain link fence posts footings were exposed and undermined. The erosion problem along the streambank is expected to continue.

Figure 8. Aiea Shopping Center Bank Erosion at Station 305+23 to 305+51.

The perspective view of water surface profile is shown in Figure 9. The Shopping Center at below Station 304+21 is subject to shallow flooding for a 100-year flooding event. The 100-year flow water surface may overtop the existing rubble retaining wall at the vicinity of Station 300+16 by approximately 5 feet (Figure 10).

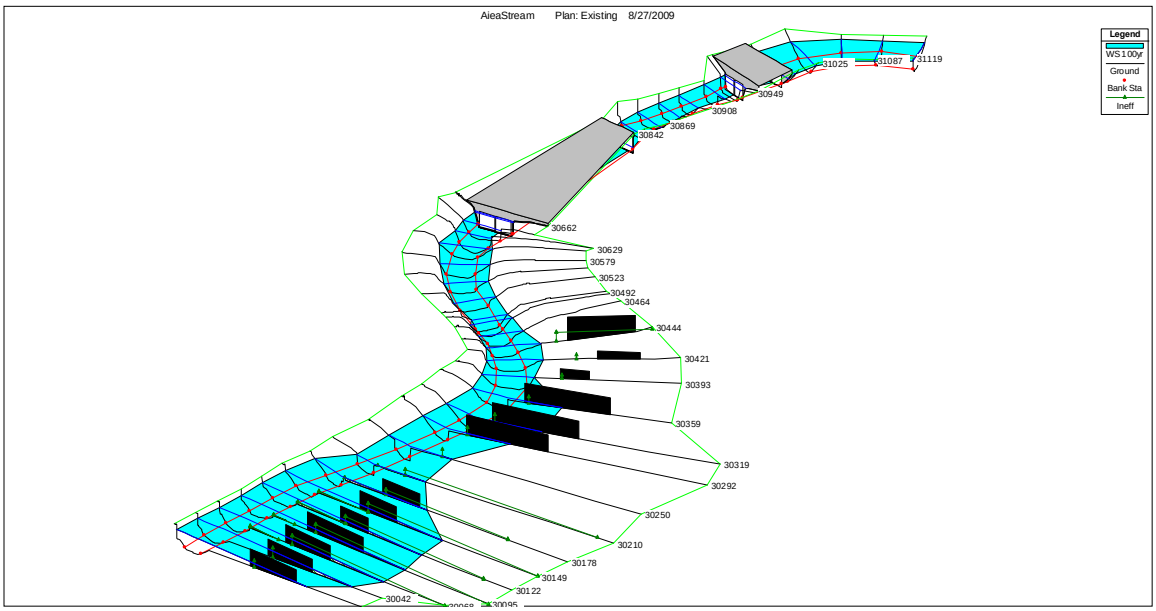


Figure 9. Model Perspective View for Existing Condition.

Figure 10. Rubble Wall at Station 300+68 to 300+16.

Detailed model output tables for 2-, 5-, 10-, 25-, 50-, 100-year floods are all listed in Appendix 12.

3.3.2. Proposed Condition

The proposed 200 feet of shotcrete wall was simulated in the model by modifying the cross sections of the west bank from Station 304+64 to Station 306+62. The irregular

shape of the west bank surface was replaced with shotcrete wall. The friction factors (Manning's 'n' values) along the west bank were adjusted from the existing calculated 'n' values to n = 0.03 or n = 0.05, which reflects the friction range for shotcrete material with rock face finishing and also the slope, contractions, expansions and sinuosity. The shape and friction factors of the bank on the other side and stream bed remain the same as the existing conditions. A brief summary is listed in Table 12.

Table 12. Friction Factor Setup in the Model.

River	Existing			Shotcrete Wall n=0.03			Shotcrete Wall n=0.05		
Station	East Bank	Chl Bed	West Bank	East Bank	Chl Bed	West Bank	East Bank	Chl Bed	West Bank
306+62	0.15	0.072	0.15	0.15	0.072	0.03	0.15	0.072	0.05
306+46	0.16	0.072	0.16	0.16	0.072	0.03	0.16	0.072	0.05
306+29	0.19	0.07	0.17	0.19	0.07	0.03	0.19	0.07	0.05
306+09	0.17	0.09	0.16	0.17	0.09	0.03	0.17	0.09	0.05
305+79	0.15	0.06	0.15	0.15	0.06	0.03	0.15	0.06	0.05
305+51	0.2	0.085	0.2	0.2	0.085	0.03	0.2	0.085	0.05
305+23	0.16	0.086	0.16	0.16	0.086	0.03	0.16	0.086	0.05
304+92	0.1	0.084	0.1	0.1	0.084	0.03	0.1	0.084	0.05
304+84	0.2	0.065	0.2	0.2	0.065	0.03	0.2	0.065	0.05
304+64	0.1	0.065	0.1	0.1	0.065	0.03	0.1	0.065	0.05

The model of the proposed condition showed similar results as compared with the existing condition. Water surface profiles of the proposed shotcrete wall with a friction factor of n = 0.03 for 2-, 5-, 10-, 25-, 50-, 100-year floods is shown in Figure 11. Water surface profiles of the proposed shotcrete wall with a friction factor of n = 0.05 for 2-, 5-, 10-, 25-, 50-, 100-year floods is shown Figure 12. Detailed model output tables for 2-, 5-, 10-, 25-, 50-, 100-year floods are all listed in Appendices 13 and 14.

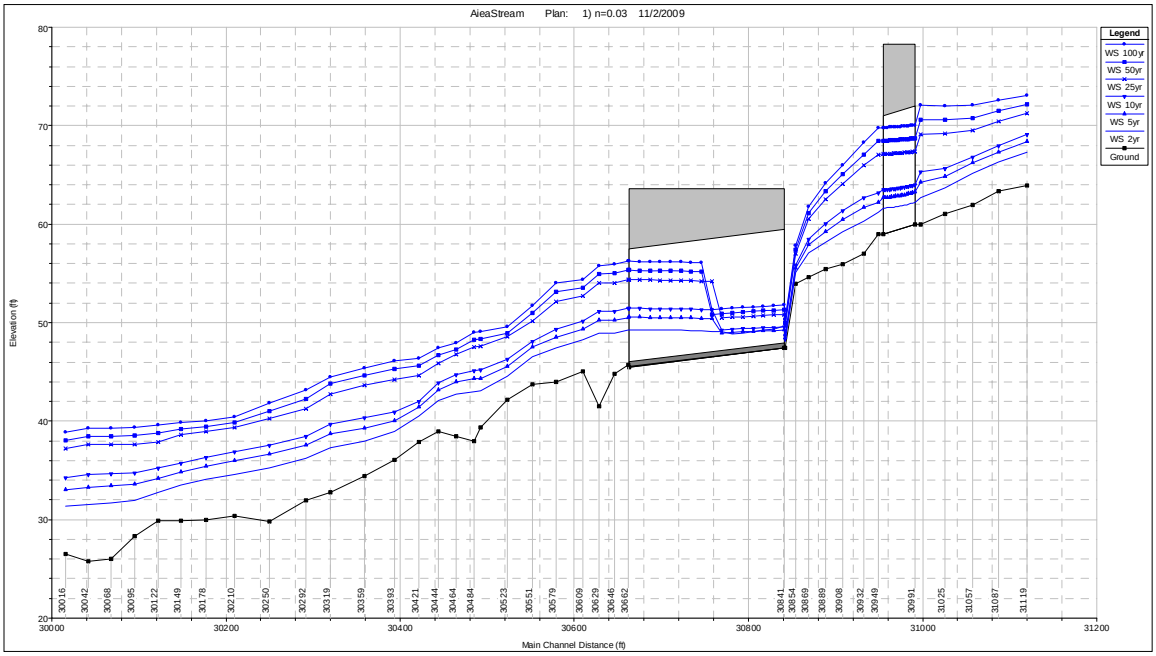


Figure 11. Water Surface Profile of Proposed Shotcrete Wall n = 0.03.

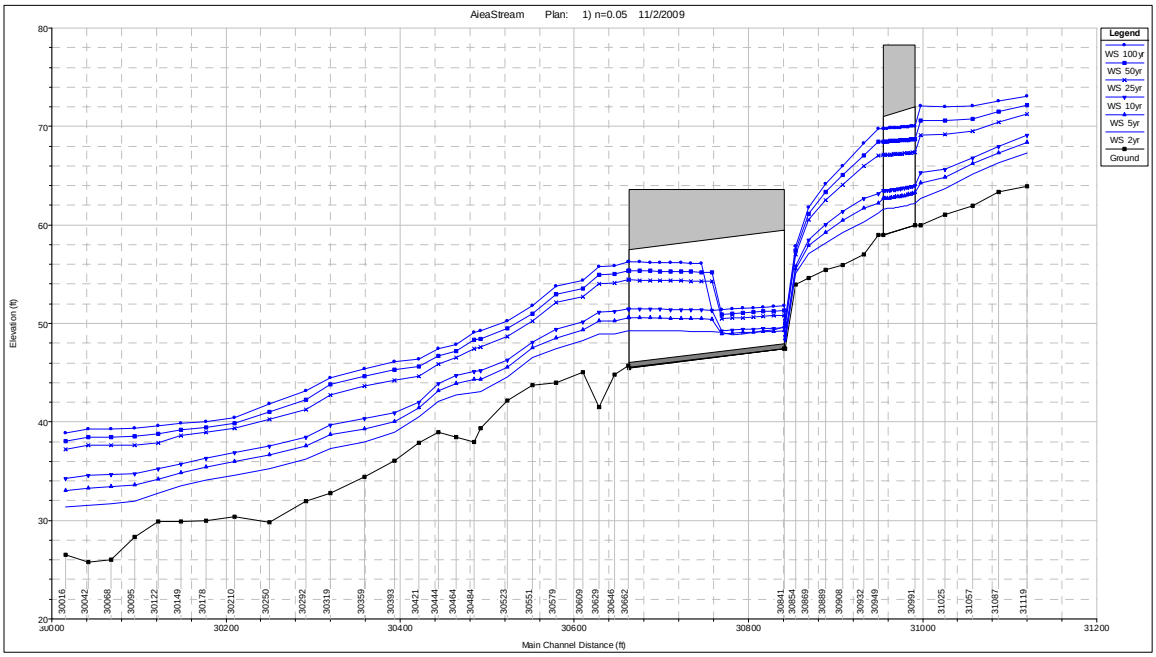


Figure 12. Water Surface Profile of Proposed Shotcrete Wall n = 0.05.

Overall, there are no significant effects on the stream flow conditions according to the model results, except that the water surface will be slightly lower from the inside of the culvert barrels and gradually returning to approximately the same depth as the existing

condition at Station 303+93 (Table 13). For the 100-year flood the maximum elevation change will be approximately 0.82’ and 0.55’ lower that the existing condition according to the model results for n = 0.03 and n = 0.05 respectively (Figure 13 and Figure 14).

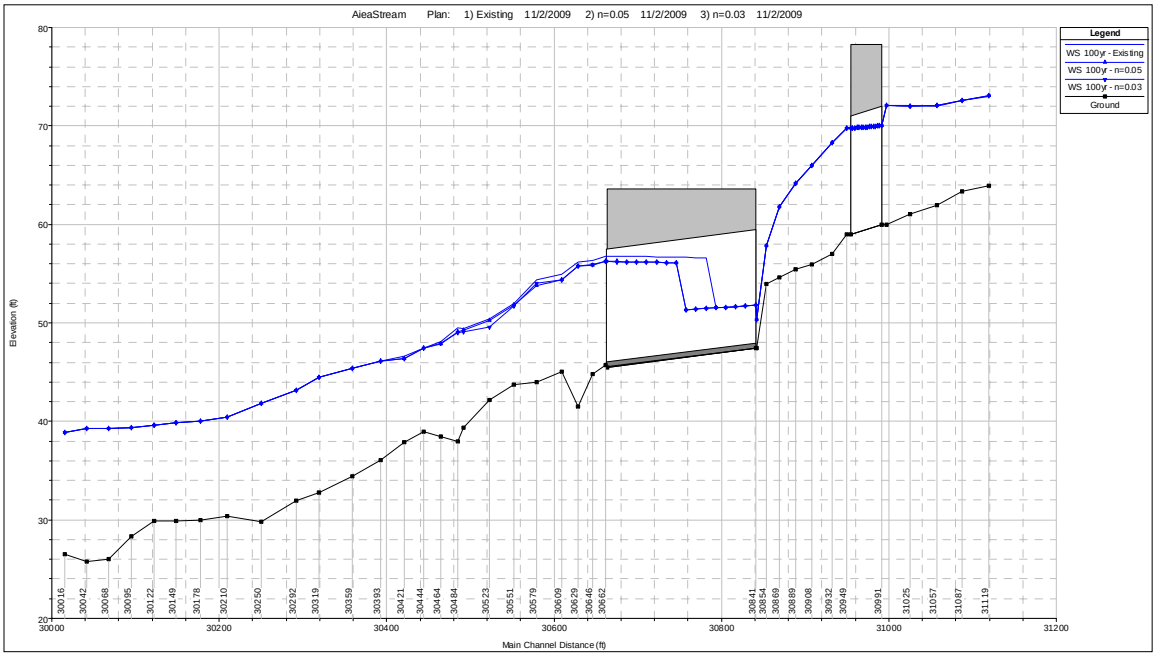


Figure 13. Water Surface Profile Comparison for 100-Year Flood.

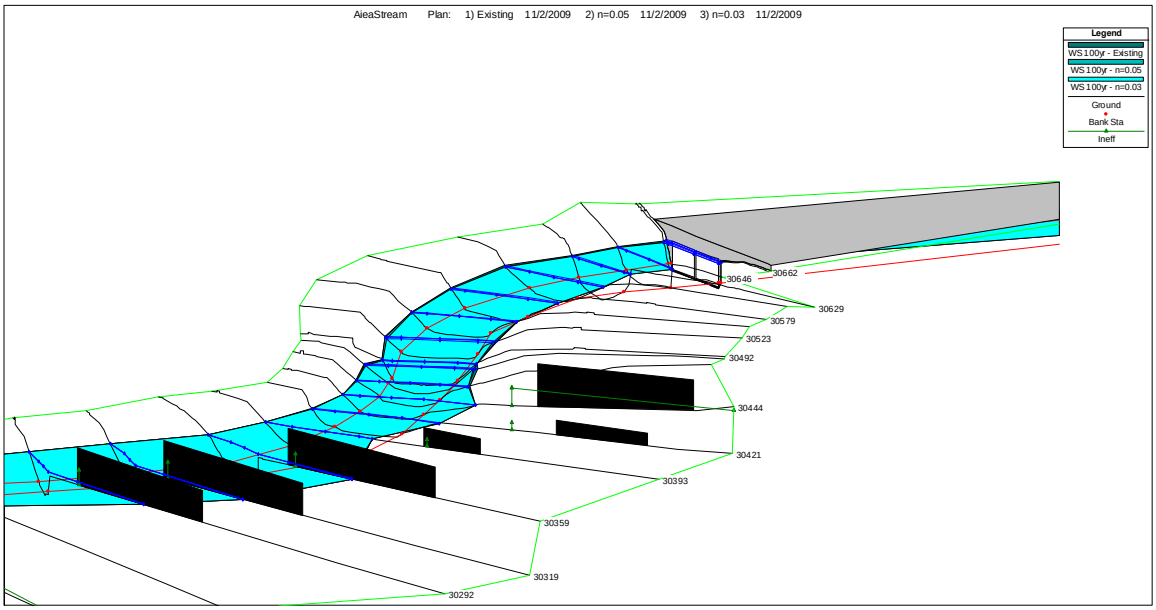


Figure 14. Perspective View of Water Surface Variations for 100-Year Flood.

Table 13. 100-Year Water Surface Elevation

River Sta	Min Ch El	L Bank El	R Bank El	W.S. Elev Existing	W.S. Elev Proposed n=0.03	W.S.Diff n=0.03	W.S. Elev Proposed n=0.05	W.S.Diff n=0.05
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
311+19	63.94	75.75	75.64	73.03	73.04	0.01	73.04	0.01
310+87	63.36	75.59	76.00	72.61	72.62	0.01	72.62	0.01
310+57	61.97	74.77	74.51	72.04	72.06	0.02	72.06	0.02
310+25	61.02	76.57	78.00	72.06	72.04	-0.02	72.04	-0.02
309+97	60.00	76.05	76.01	72.07	72.07	0.00	72.07	0.00
309+91	Culvert	-	-	-	-	-	-	-
309+49	59.00	69.53	71.80	69.78	69.78	0.00	69.78	0.00
309+32	57.00	67.00	71.56	68.28	68.28	0.00	68.28	0.00
309+08	55.95	68.00	71.56	66.01	66.01	0.00	66.01	0.00
308+89	55.45	66.42	71.56	64.17	64.17	0.00	64.17	0.00
308+69	54.64	63.64	71.56	61.79	61.79	0.00	61.79	0.00
308+54	53.98	60.90	71.56	57.85	57.85	0.00	57.85	0.00
308+42	47.45	60.58	60.48	50.34	50.34	0.00	50.34	0.00
308+41	Culvert	-	-	-	-	-	-	-
306+62	45.70	57.64	60.00	56.78	56.24	-0.54	56.25	-0.53
306+46	44.78	57.97	58.00	56.31	55.92	-0.39	55.87	-0.44
306+29	41.50	57.93	62.00	56.21	55.79	-0.42	55.74	-0.47
306+09	45.04	59.90	62.18	54.93	54.38	-0.55	54.38	-0.55
305+79	43.94	58.80	59.99	54.36	54.00	-0.36	53.81	-0.55
305+51	43.74	57.99	61.99	52.01	51.75	-0.26	51.80	-0.21
305+23	42.18	58.00	59.98	50.42	49.60	-0.82	50.27	-0.15
304+92	39.37	58.17	58.09	49.41	49.08	-0.33	49.29	-0.12
304+84	38.00	58.00	58.05	49.47	48.98	-0.49	49.11	-0.36
304+64	38.44	58.02	57.80	48.14	47.92	-0.22	47.84	-0.30
304+44	38.98	48.21	56.10	47.47	47.42	-0.05	47.42	-0.05
304+21	37.88	46.67	54.00	46.58	46.39	-0.19	46.39	-0.19
303+93	36.07	46.36	55.00	46.15	46.15	0.00	46.15	0.00
303+59	34.42	44.21	53.95	45.40	45.40	0.00	45.40	0.00
303+19	32.80	42.83	50.15	44.47	44.47	0.00	44.47	0.00
302+92	31.98	41.74	48.20	43.20	43.20	0.00	43.20	0.00
302+50	29.80	40.81	45.50	41.87	41.87	0.00	41.87	0.00
302+10	30.40	40.07	43.27	40.40	40.40	0.00	40.40	0.00
301+78	29.98	39.79	43.21	40.05	40.05	0.00	40.05	0.00
301+49	29.92	36.86	44.19	39.89	39.89	0.00	39.89	0.00
301+22	29.85	37.33	44.56	39.61	39.61	0.00	39.61	0.00
300+95	28.31	35.42	44.40	39.36	39.36	0.00	39.36	0.00
300+68	26.00	34.44	43.24	39.29	39.29	0.00	39.29	0.00
300+42	25.80	32.00	42.75	39.27	39.27	0.00	39.27	0.00
300+16	26.54	33.39	42.75	38.89	38.89	0.00	38.89	0.00

Flow velocity in the main channel and along the east bank is approximately the same as the existing condition (Appendix 20, 21), except that the flow velocities will increase by approximately 8.26 feet per second and 4.46 feet per second in average (for 100-year flood) along the west bank where the shotcrete wall is proposed for the friction factor of n = 0.03 and n = 0.05 respectively (Figure 15). However at the end of shotcrete wall (Station 304+21) the flow velocity returns to the same as existing condition. Detailed calculation sheets are shown in the Appendix 22.

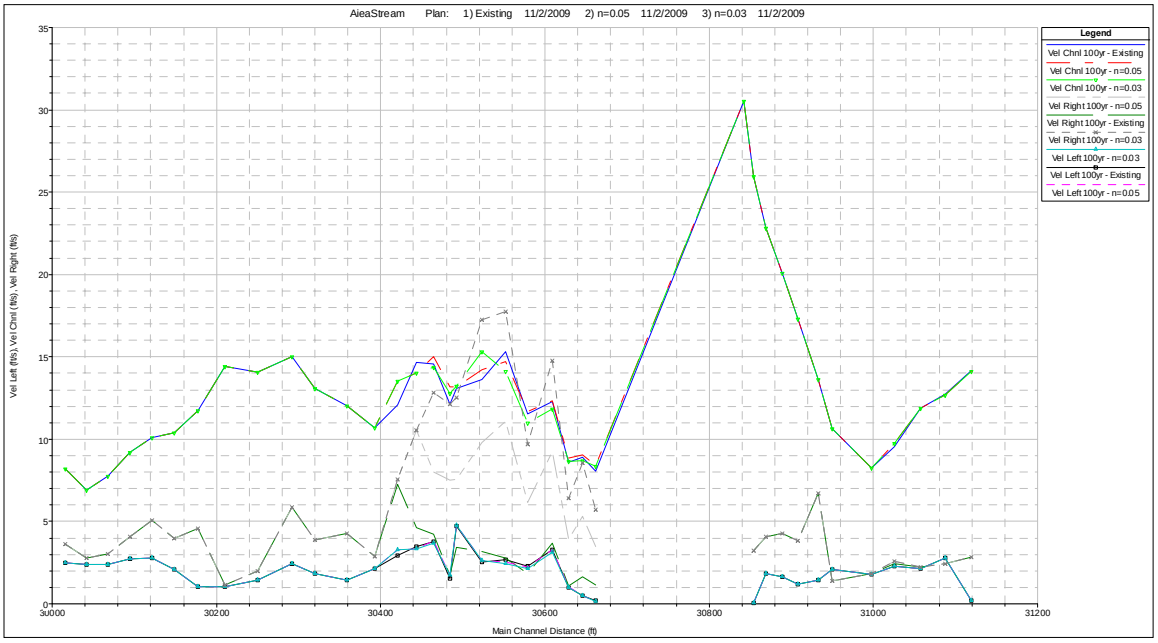


Figure 15. Velocity Profile Comparisons for 100-Year Flood.

The proposed shotcrete wall does not pose any significant superelevation difference from the existing condition due to the flow velocity in the main channel is approximately the same. The superelevation calculation results are shown in Appendix 23.

3.4. Conclusions

The hydraulic evaluation discussed herein shows that the shotcrete wall along the Aiea Shopping Center can be constructed to protect the bank erosion without increasing in

flood levels and maintaining approximately the same velocities as existing condition. The hydraulic analysis was based upon approximation of the proposed shotcrete wall placement, as such the results of the analysis presented herein should be considered as conditional pending the detailed design of the wall. The results of the hydraulic analysis will need to be revised to reflect the designed geometry of the shotcrete wall for incorporation into the final hydraulic report.

4. References

[1] Environmental Impact Statement for the Flood control Project, Department of Public Works City and County of Honolulu, 1977

[2] The National Flood-Frequency Program—Methods for Estimating Flood Magnitude and Frequency in Rural Areas in Hawaii, Island of Oahu, USGS, 2000

[3] Rainfall Frequency Study for Oahu, Department of Land and Natural Resources Division of Water and Land Development, State of Hawaii, 1984

[4] Precipitation-Frequency Atlas of the United States Hawaiian Islands, NOAA Atlas 14, Volume 4 Version 2.0, 2009

[5] Flood Insurance Study for City and County of Honolulu Hawaii, Federal Emergency Management Agency, 2004

[6] Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains, United States Geological Survey Water-supply Paper 2339, 1989

5. Appendices List

The appendices are project location map, reference charts and equations, detailed hydrologic & hydraulics computer calculation output graphs and tables.

APPENDIX 1: Aiea Stream Project Location Map

APPENDIX 2: Time of Concentration

APPENDIX 3: Curve Number

APPENDIX 4: Plate 6 – Storm Drainage Standards, City and County of Honolulu

APPENDIX 5: USGS Regression Method

APPENDIX 6: NRCS WinTR-20 Model Results

APPENDIX 7: HEC-RAS Model Geometry Setup

APPENDIX 8: HEC-RAS Cross Sections of Existing Condition

APPENDIX 9: HEC-RAS Cross Sections of Proposed Condition n=0.03

APPENDIX 10: HEC-RAS Cross Sections of Proposed Condition n=0.05

APPENDIX 11: HEC-RAS Friction Coefficient Table

APPENDIX 12: HEC-RAS Water Surface Profile Results for Existing Condition

APPENDIX 13: HEC-RAS Water Surface Profile Results for Proposed Condition n=0.03

APPENDIX 14: HEC-RAS Water Surface Profile Results for Proposed Condition n=0.05

APPENDIX 15: HEC-RAS Water Surface Profile Results Comparisons Figures

APPENDIX 16: HEC-RAS Model Results Table for Existing Condition

APPENDIX 17: HEC-RAS Model Results Table for Proposed Condition n=0.03

APPENDIX 18: HEC-RAS Model Results Table for Proposed Condition n=0.05

APPENDIX 19: HEC-RAS Model Results Comparison for Water Surface

APPENDIX 20: HEC-RAS Model Results Comparison for Channel Velocity

APPENDIX 21: HEC-RAS Model Results Comparison for Left Bank Velocity

APPENDIX 22: HEC-RAS Model Results Comparison for Right Bank Velocity

APPENDIX 23: Superelevation Calculation

Aiea Stream Field Report

Date: 11/6/2009

On site 0830 – 1100

Personnel: Robert Bourke, Environmental Professional
Jake Crawford, Technician

BACKGROUND

The right bank of Aiea Stream below the H1 Moanalua Freeway underpass has been experiencing erosion that may impact the foundation of an adjacent building. To stabilize the bank erosion, a shot-crete wall has been proposed.

The purpose of the field visit was to determine 1) the presence of absence of wetlands adjoining the stream in the project area and 2) locate and flag the OHWM along the stream in the vicinity of the project.

Aiea Stream, State DLNR Code 4-03, is classified as an intermittent stream only flowing during active rainfall runoff events with the exception of un-quantified groundwater input near the mouth of the stream just prior to entering the East Loch of Pearl Harbor on the south shore of Oahu. There are no USGS flow records published for Aiea Stream. The stream is just over 4 miles long contained within a watershed area of only about 1.3 square miles and only reaches about half way to the crest of the Koolau Mountain Range. The elevation of the stream bed varies from about 38-feet to 45 feet along the 200-foot length of the proposed shotcrete wall approximately 0.3 miles above the stream mouth in Pearl Harbor. Weather during the preceding three days was moderately rainy.

FIELD NOTES

The site was accessed from Laka Place beginning about 0830 am Friday November 11, 2009. Weather was sunny with tradewinds and no active rainfall, although there had been significant rainfall in the mountains for several days prior to the site visit. We walked up stream beneath the H-1 Freeway and beyond that beneath the Ulune Street Bridge. There was a slight flow in the stream (<< 1gps) above the freeway, but this flow went to ground in a small pool through the broken concrete liner just above the H-1 Freeway underpass. The stream was walked from Ulune Street down to approximately 400 feet below the freeway (Station 302+50). The OHWM was marked with orange flags (or orange spray-paint marks on hard surfaces) at 16 numbered and paired left and right bank locations over this 400-foot reach (details below). Two stream cross sections were measured near Station305+60 (mid-project) and Station 304+50 (below lower end of project). Figure 1 shows the approximate locations of the cross sections and of the OHWM flags. The OHWM flags will be surveyed by others.

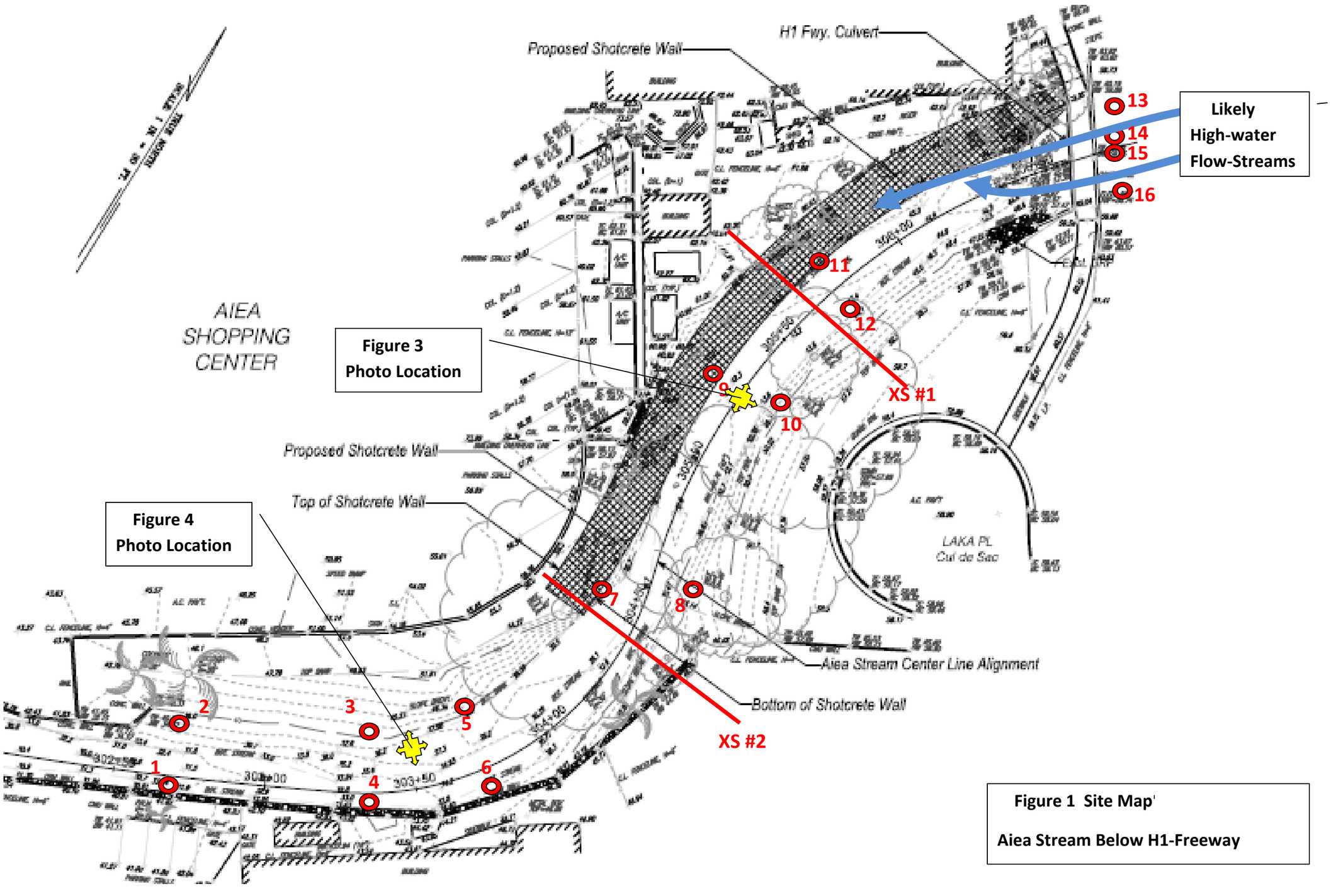


Figure 1 Site Map

Aiea Stream Below H1-Freeway

Above Ulune Street the stream channel and left bank are natural and the right bank is a vertical grouted rock wall. Twin box culverts below Ulune Street transition to a concrete lined channel down to the H-1 Freeway. At the entrance to the freeway underpass the concrete bed slopes steeply (45-degrees) down a drop structure entering twin box culverts. Each box culver measures approximately 12 feet high and 14 feet across. The right hand culvert is clear, but the left culvert has a 2 to 4 foot thick layer of rock rubble over the bottom.

Below the freeway the left side of the stream is filled with rock rubble which appears to have exited the left-hand culvert (Figure 2). This contrasts with the clear, rubble free, right-hand culvert that transitions from an elevation of 45.51-ft to the stream bed across a 3-foot drop into a scoured stream bed. The bed immediately below the right-hand culvert exit (Station 306+30) has a surveyed elevation of 41.5 feet. The bed of the stream rises from this point to an elevation of 44.9 feet, about 50-feet below the freeway (Station 306+00). Approximately 100 feet of the right bank of the stream below the freeway (Station 305+00 to306+) consists of a steep dirt slope with an embeded layer of rounded river-rock visible about 5 feet above the stream bed (Figure 3). The absence of any observed layering in the dirt and angular rocks above this level suggests that this material may have been placed as fill. Figure 3 photos were taken near station 305+25 and show both the river cobble and bare dirt slopes on the right bank. Stream cross section #1 (Figures 1 and Appendix) was taken near this site at Section 305+70.

Figure 2 Exit of twin culverts beneath H1 Freeway above site. Left culvert (right side of picture) has 2-feet of rock rubble over bottom. Left culvert is clear and drops about 3 feet to eroded stream bed at exit.

The bed of the stream consists of rock and rubble with little or no fines for about 150 feet below the freeway. The rock and boulder bed of the stream falls sharply at station 305+25 and after this point the stream bed contains a significant quantity of fine sand and gravel. Beginning 150 feet below the freeway (Station 305+00) the right bank transitions to rounded river-rock from the stream bed to at least 10 feet above the bed. This

rock bed supports a very large (4-foot diameter) tree overhanging the right bank and growing over what appears to be a 16-inch drain at station 304+40. Cross section #2 (Figures 1 and 5) was taken near station 104+40 beneath this large tree.

Below Station 304+50 the stream curves to the right with point-bar deposits on the right bank and a vertical concrete rock (CMU) wall on the left bank. The footing of the CMU wall is undermined by about 1-foot in several locations between stations 302+50 and 304+00. The bed consists of a mixture of fine sediments and rock rubble blending to a gradual dirt slope on the right bank. Below Station 302+50 it appears that the stream bed remains natural but is contained by vertical walls on both sides into the distance. The photos in Figure 4 were taken near station 303+50 approximately 80 feet below the end of the proposed shotcrete wall.

Figure 3 Right Bank near center of proposed project. Note line of rounded "river rock" embedded in bank from arrow to hand indicating possible historical elevation of a portion of the stream bed. Unlayered dirt and angular rocks above this elevation are indicative of fill. OHWM shown as dotted red line.

ORDINARY HIGH WATER MARK DETERMINATION

The ordinary high water mark (OHWM) determination was based primarily on the presence of exposed roots and decreased leaf liter and organic soil matrix along the dirt banks and upon staining of rock or concrete surfaces on vertical banks. Orange flags (# 2, 3, 5, 7, 9, 11, numbered from down to up stream) were inserted into the right stream bank at the OHWM. A flag or orange paint mark on the left bank is paired with each of the flags on the right bank. Paint marks inside the freeway culverts (#13,14, right culvert; 15,16 left culvert) were placed to document the different flows in each of the culverts. The positions of the marks were noted approximately on the field survey map as reproduced in Figure 1. Photos of each of the marks are included in the Appendix.

The OHWM on “natural” (non-concrete or rock) was interpreted as that location on the bank where there was a discernable decrease in organic matter and leaf liter exposing roots of adjacent trees and bushes. All rock rubble within the stream bed and any point bars or drift islands within the stream

boundary were below the OHWM. In several locations there were tall grasses below the OHWM but no young trees or saplings were seen below this line on either bank. The OHWM is located about a foot above the active rock stream bed. The OHWM was not confused with active erosion slopes of bare dirt which typically truncated well above the OHWM where grasses were thick enough to hold the surface together. On the left bank below Station 304+50 the OHWM was against a vertical concrete reinforced rock wall as discerned by a horizontal demarcation of color change. Several sections of this wall's footing were undermined by 12-18 inches. A horizontal orange paint marking was painted on the wall at the elevation of the OHWM. In general the OHWM appeared to be only about 1.5 feet above the low point in the natural stream bed. Within the culverts beneath the freeway, the right hand box culvert (without stones) obviously had a much deeper flow (~1 ft) as seen by a dark stain on the concrete, as compared to the left (stone filled) culvert where the OHWM stain on the sidewall was barely several inches above the stone bottom.

Cross sections were physically measured at two locations using a level stretched tape and surveyors staff. As the catinary in the level tape was less than 0.5 ft this deviation was not accounted for in the cross sections. XS#1 was made near the center of the proposed shotcrete wall at Station 305+70 and included tall grass growing on a bar below the right bank. XS#2 was made at the lower end of the proposed shotcrete wall at Station 304+40. Interpretation of the OHWM on these drawings shows a cross sectional area of 9.0 and 9.5 square feet for each section.

INTERPRETATION

This nontidal stream flows directly to the East Loch of Pearl Harbor, is classified as intermittent by the State of Hawaii and appears to flow only during either very heavy rainfall events or in response to rainfall directly on the site. There was no water flow at the project site immediately below the H1-Freeway at the time of inspection even though the preceding days had recorded significant rainfall in the mountains above the site. When the stream does flow, it is a potential source of significant inflow and potential pollutants to Pearl Harbor. There is a great deal of trash within the stream bed and banks and numerous storm drain inlets from which this trash and other potential non-point source pollutants could emanate. There were no wetland indicators visible in or adjacent to the project site. This stream reach should be classified as an intermittent tributary to a water of the US from it's mouth at Pearl Harbor up past the project site to the end of the reach at the first main bifurcation approximately 1.5 miles above the H1 Freeway.

This stream bed has obviously undergone a great deal of man-induced change in the past so the long term bed and bank features characteristic of the OHWM in a stable stream are either not present or deemed not to be reliable. The OHWM appears to range from about 1.0 to 2.0 feet above the lowest bed in any cross section. The exception to this is within the tunnel beneath the freeway where flow speeds are likely much higher and the OHWM lower, and directly below the freeway tunnel outfall where scouring has left a relatively deep pool. Graphical interpretation of the two cross sections indicates a cross sectional area below the OHWM of about 9 to 9.5 square feet. Given the roughness of the stream bed and an average flow speed of 5 ft/sec this would appear reasonable to accommodate a

flow of 40-50 cubic feet per second during the stream forming flow expected to occur every 1.5 – 2 years.

The right bank proposed for structural reinforcement consists primarily of a bare unlayered dirt slope consistent with the application of fill on this bank prior to construction of the adjacent building.

The retaining wall on the left bank below the project site shows undermining of its foundation. It is reasonable to assume that a decrease in roughness on the right bank up stream at the project site, could cause an increase in the flow energy impinging upon the retaining wall on the left bank down stream. The potential secondary impact on this down stream wall should be considered in the project design.

Report Respectively Submitted

Robert E. Bourke
Environmental Professional
Oceanit Labs, Inc.
828 Fort Street Mall, Suite 600
Honolulu Hawaii.

Figure 4 Aiea Stream Location 1. Top: Up-stream view showing right bank (left side of photo) proposed for shot-crete stabilization.

Bottom: Down-stream view same location. Note line of river rock mid-face on right bank and absence of roots on face of right bank.

Figure 5 Stream bed at Station 303+40 about 100 feet below lower end of project site. Top: Upstream view. Large tree in background left marks lower end of proposed shotcrete wall on right bank. Note undermining of rock wall on left bank (right side upper photo. Bottom: Downstream view from same location showing grass slope on right bank and vertical concrete reinforced rock wall on left bank. Dashed red line represents approximate OHWM.

Flag 1

Flag 2

Flag 3

Flag 4

Flag 5

Flag 6

Flag 7

Flag 8

Flag 9

Flag 10

Flag 11

Flag 12

Flag 13

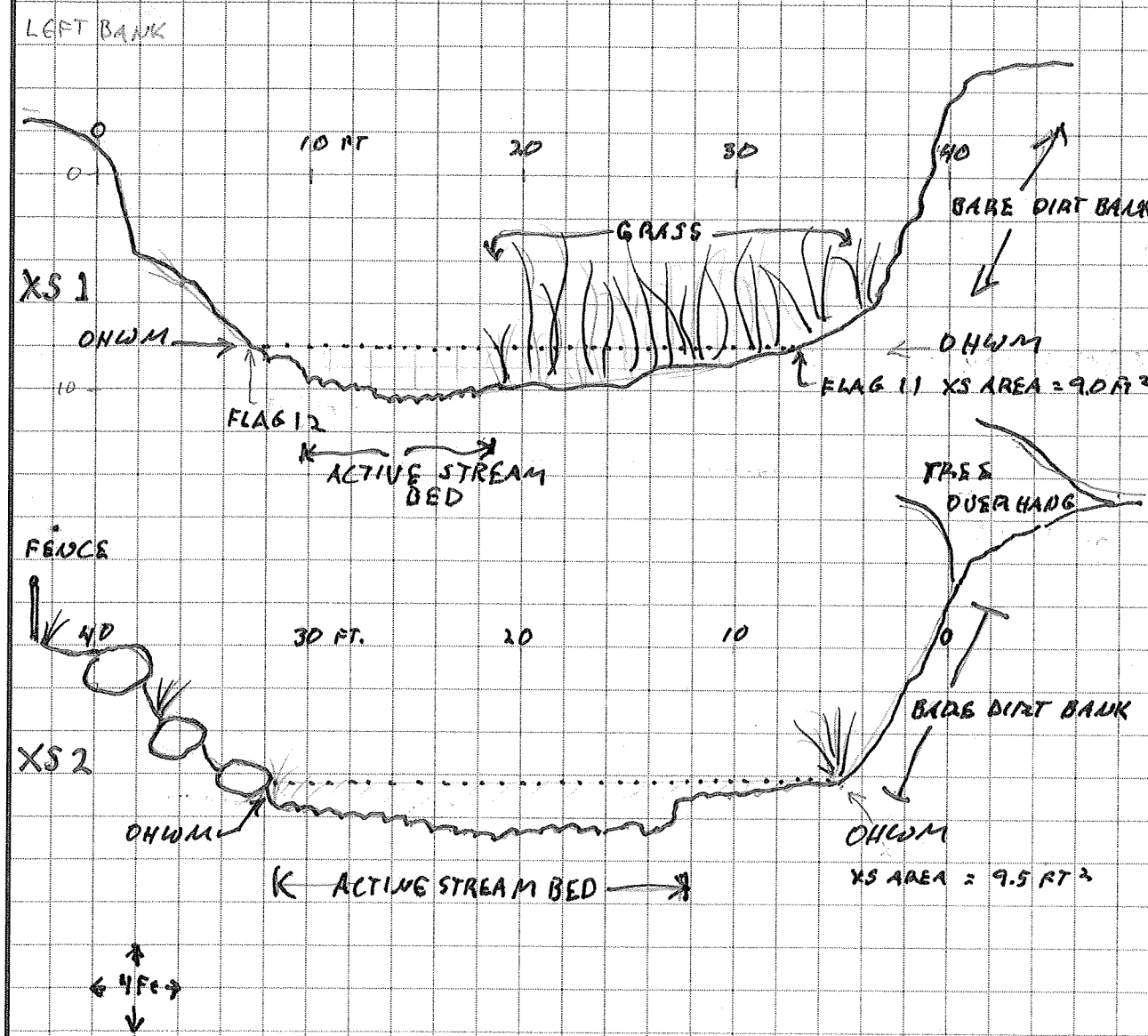
Flag 14

Flag 15

Flag 16

XS1 ~ 300 ft BELOW FWY DIRECTLY INTO ERODING RIGHT BANK
STATION 305+60

XS2 ~ 600 ft BELOW FWY BELOW LARGE TREE & DRAIN ON R. BANK
STATION 304+50



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